Products finishing

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Volume 8 | JUNE, 1944 | Number 9

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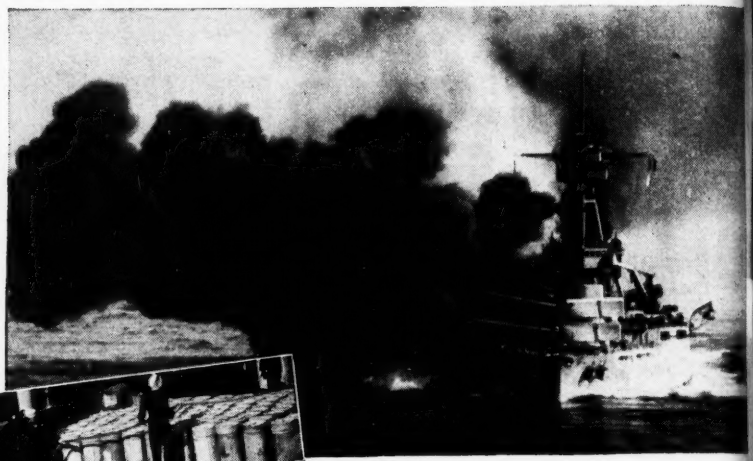

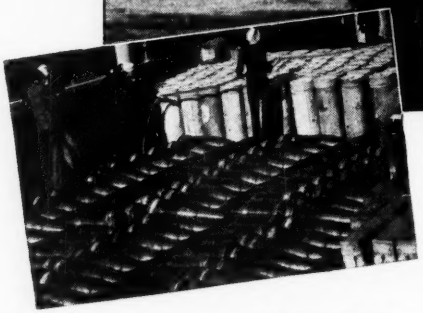

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For Steel Shells, Bombs, Cartridge Cases

Here are two specification finishes with the usual Egyptian plus. They meet every requirement from Uncle Sam's standpoint and every requirement which you set as to speed, ease of application, drying and appearance.

Apply to bare metal by spray, brush or dip. Sprayed on, they air-dry in 10 minutes for handling and top coating with enamel. If desired they can be baked 10 minutes at 250 degrees F.

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Products Finishing

ON JUNE 11, 12, 13, and 14, the 32nd American Electroplaters' Society Convention will be held in Cleveland, Ohio. Great plans have been made to make this year's Convention a memorable one. Those who attended the Convention last year will well remember its success and will anticipate the same prosperous fortune.

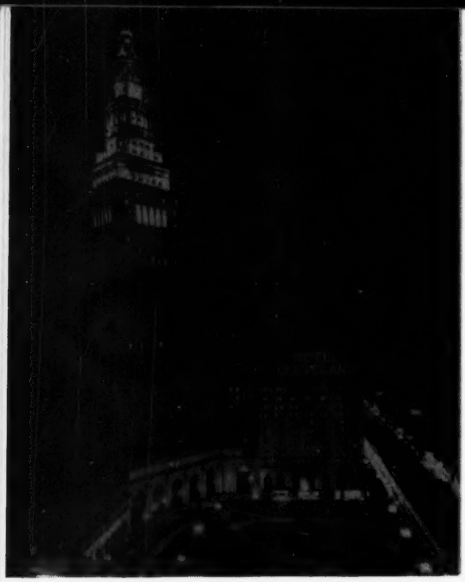
A well-planned Educational Session has been arranged. Prominent men in the metal-finishing field will be introduced as speakers. The papers to be presented have been carefully selected for their valuable information on today's needs. The papers will contain information relative to research by the Bureau of Standards, "The Iridite Process," "Porous Chrome Plating," "Plastic and Plating on Plastics," "The Relation of Defects in Electroplate to the Gas Content of the Basis Metal," "A Rapid Determination of Copper in Nickel Plating Baths," "An Extension of Applied Research to Hard Chrome," "Hard Chrome Problems," "Electro-forming," "Alloy Plating," "A Study of the Reactions in Nickel Plating," "Anozinc and other New Coatings on Zinc," "The Finish is Always in Sight," "Dyed Anodic Coatings on Aluminum" and "Anodizing of Aluminum." A very unique Exhibit Show which will be long remembered has been arranged by the Exhibits Committee.

Conventions provide an excellent opportunity for members to discuss their problems, make new acquaintances and renew old friendships. We will greet friends whom we have not seen since the last Convention in 1943, which topped the record of all previous Conventions with a registration of 922.

Not only have plans been made for the men who attend, but also preparations have been made by the Ladies Committee for the entertainment of the ladies in attendance.

Let's all attend the 32nd Convention, top the registration of last year, get all we can out of it, and go home with worth-while and pleasant memories.

George Wagner
President.



A. E. S. 32nd Annual Conference

Official Program of A. E. S. 32nd Annual Conference

June, 1944—Cleveland, Ohio

Hotel Cleveland, Conference Headquarters

★

Sunday Afternoon — June 11, 1944 — 2:30 P. M.

REGISTRATION

Mezzanine Floor—Hotel Cleveland

The registration fee of five dollars for each person attending the conference will include a book of tickets to be used for all the social events on the program.

Monday Morning — June 12, 1944 — 8:00 A. M.

Registration continued throughout the day. Mezzanine Floor. Hotel Cleveland.

Monday Morning — June 12, 1944 — 9:00 A. M.

OPENING SESSION

Invocation.....Rev. F. C. Mesle
Welcome to Cleveland.....Honorable Frank J. Lausche, Mayor
Response.....William D. Scott, General Chairman
Greeting from the Cleveland Branch,
George B. Svenson, President, Cleveland Branch
Presidential Address..George Wagner, President, American Electroplaters' Society

Monday Morning — June 12, 1944 — 10:30 A. M.

FIRST EDUCATIONAL SESSION

President George Wagner, Presiding

"A Report on Research"

DR. WILLIAM BLUM, *Bureau of Standards, Washington, D. C.*

This report will cover the research program in its relation to military requirements and will summarize the Bureau's efforts in electroplating for the past year.

"The Iridite Process"

A. G. TAYLOR, *Rheem Research Products, Inc., Baltimore, Maryland*

This paper will cover the method and salt-spray records of Iridite coating. In addition, there will be a visual demonstration of its application.

Monday Afternoon — June 12, 1944 — 1:00 P. M.

SECOND EDUCATIONAL SESSION

Carl E. Heussner, Chrysler Corporation, Presiding

"Porous Chrome Plating"

T. G. COYLE, *United Chromium, Inc., New York City*

Mr. Coyle's paper will present the principles and operating practices in the production and finishing of the plate. Data on control of the bath and current will be presented. With the exception of the finishing and inspection equipment, the regulation equipment found in the plating room may be employed. Racking and a discussion of the application of the process will be given.

"Plastics and Plating on Plastics"

HAROLD NARCUS, *Plating Processes Corporation, Holyoke, Massachusetts*

An excellent analysis of a present and post-war problem, with explanation of the various types of plastics and the methods of electroplating, past and present.

"The Relation of Defects in Electroplate to the Gas Content of the Basis Metal"

CARL L. ZAPFFE AND CHARLES L. FAUST, *Battelle Memorial Institute, Columbus, Ohio*

This paper presents further conclusions of the paper by Zapffe and Faust entitled "Metallurgical Aspects of Hydrogen in Electroplating," given in Dayton, Ohio, at the 1940 Conference.

"A Rapid Determination of Copper in Nickel Plating Baths"

B. B. KNAPP, *International Nickel Company Research Laboratory, Bayonne, New Jersey*

Copper present in nickel solutions has not only proved troublesome, but also has been difficult to trace. Mr. Knapp has devised a method which will have an immediate and post-war application.

Monday Evening — June 12, 1944 — 8:00 P. M.

INTERNATIONAL FELLOWSHIP CLUB OPEN HOUSE

On Monday evening the International Fellowship Club will be the host. A reception and dancing will be held in the Ball Room. Mezzanine Floor. Refreshments and a place for visiting

will be found in the Red Room. Refreshments will be served on presentation of the ticket found in the coupon book. (All waiters' gratuities have been met by the Club.)

Tuesday Morning — June 13, 1944 — 9:00 A. M.

THIRD EDUCATIONAL SESSION

Joseph Ruff, Trico Corporation, Presiding

"An Extension of Applied Research to Hard Chrome"

DR. D. A. COTTON, *Delco-Remy Division, General Motors Corporation, Anderson, Indiana*

A very practical paper which should prove especially interesting to those who heard Dr. Cotton at Asbury Park. He brought hard chrome plating out of the test tube into the shop and made it show a profit.

"Porous Chrome"

RUSSELL PYLE, *Van der Horst Corporation, Olean, New York*

This speaker will cover the technical methods and the problems involved in the porous chrome process. Mr. Pyle will also cover the industrial application of this type of plating and its many advantages unknown at present.

"Hard Chrome Problems"

ARTHUR LOGOZZO, *MacDermid, Inc., Waterbury, Connecticut*

Mr. Logozzo is considered an authority in this field and will be glad to answer specific questions and help with individual problems. (Ample time has been allotted these papers so that the audience may profit from a full discussion of them.)

Tuesday Noon — June 13, 1944 — 12:30 P. M.

VICTORY LUNCHEON

Through the courtesy of the Frederick Gumm Chemical Company

Congressman Fred A. Hartley will be the speaker. He has represented as his district the industrial area of New Jersey which includes Newark. Although a young man, Congressman Hartley has been returned to Congress eight times and has been a member of many important committees.

(A coupon for this luncheon is provided in the book of tickets received at registration.)

Tuesday Afternoon — June 13, 1944 — 2:00 P. M.

William L. Phillips, General Motors Corporation, Presiding

"Electro-forming"

FRANK SAVAGE, *Conn Instrument Company, Elkhart, Indiana*

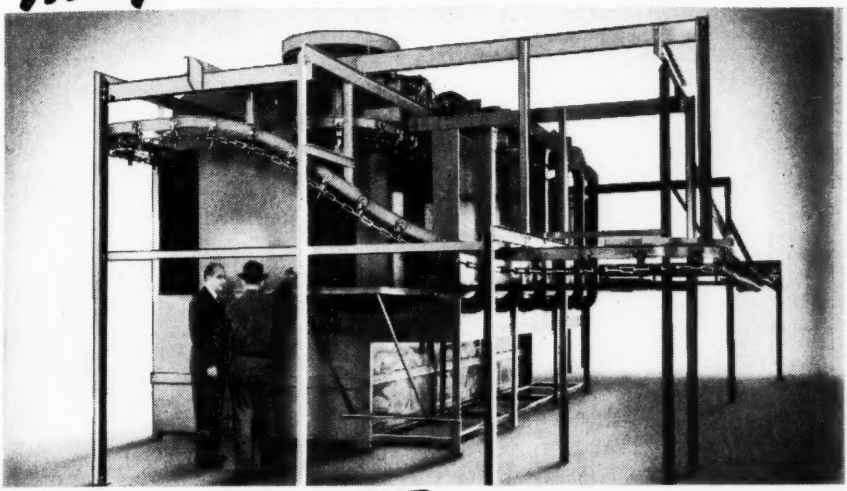
Mr. Savage has had a wealth of practical experience in a field that has been neglected by our industry. His paper should be of great value to companies that are interested in post-war ideas.

"Alloy Plating"

M. DIGGIN, *Hanson-Van Winkle-Munning Company, Matawan, New Jersey, and* DR. GEORGE JERNSTEDT, *Westinghouse Electric & Mfg. Company, East Pittsburgh, Pennsylvania*

Presented jointly by Dr. Jernstedt and Mr. Diggin, this paper will cover a recent practical application of alloy plating which has been conducted under Dr. Jernstedt's supervision.

They don't come too Big!



For Alvey-Ferguson Engineers...

TWENTY-SEVEN TONS of water are required to fill this huge A-F Cleaning and Drying Machine to operating level.

SIZE ALONE, however, is not the true test of operating efficiency. Incorporated in this fourteen-foot giant are special processes and an engineering skill that cannot be described in this advertisement.

If you have a cleaning and finishing problem and one of our standard machines will not solve it, please remember that our engineers are specialists in *custom-built* equipment! Write today.

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CONVEYING A-F MACHINERY **Alvey-Ferguson**

"A Study of the Reactions in Nickel Plating"

DR. V. H. WAITE, *McGean Chemical Company, Cleveland, Ohio*

The information contained in Dr. Waite's paper is the result of careful study and should prove of practical value to the plater as well as the technical group.

"Zinc Plating—Yesterday and Today"

DR. CHRISTIAN J. WERNLUND, *Research Laboratories, E. I. du Pont de Nemours & Co., Niagara Falls, New York*

This subject will be reviewed by Dr. Wernlund with his usual enthusiasm and gives promise of an abundance of information on a very important and timely topic.

Tuesday Evening — June 13, 1944 — 8:00 P. M.

There will be no technical session on Tuesday evening and the omission has been deliberate. Many of the delegates have expressed the desire for time to devote to personal contacts with other members from other parts of the country who are engaged in the same type of work.

The Program Committee suggests that an examination of the registration list will enable members to locate groups or individuals they want to contact.

Anyone who has a specific problem to discuss with an authority should see the Educational Chairman, John Honnecker. He will be glad to assist in making the necessary arrangements.

Wednesday Morning — June 14, 1944 — 9:00 A. M.

William J. Neill, Columbus Metal Products, Presiding

"The Finish Is Always in Sight"

RALPH E. PETTIT, *Aluminum Company of America, Pittsburgh, Pennsylvania*

Mr. Pettit will give a strictly non-technical talk which will review the aluminum situation from its inception to the present day. A 30-minute technicolor film will be shown and the talk will be illustrated with slides.

"Dyed Anodic Coatings on Aluminum Produced by the Chromic Acid Process"

L. E. TUBBS, *Mutual Chemical Company, Baltimore, Maryland*

The process for the production of colored finishes on chromic acid anodized aluminum will be described. Attention will be given to the preparation of the metal, anodizing and dyeing. Specific problems presented by certain alloys will be discussed and the value of certain dyes indicated. From the information given, the anodizer will have a basis for further investigation in addition to being able to produce definite results in current applications.

"Anodizing of Aluminum"

ALBERT R. GOODKIN, *All-Brite Chemical Company, Waterbury, Connecticut*

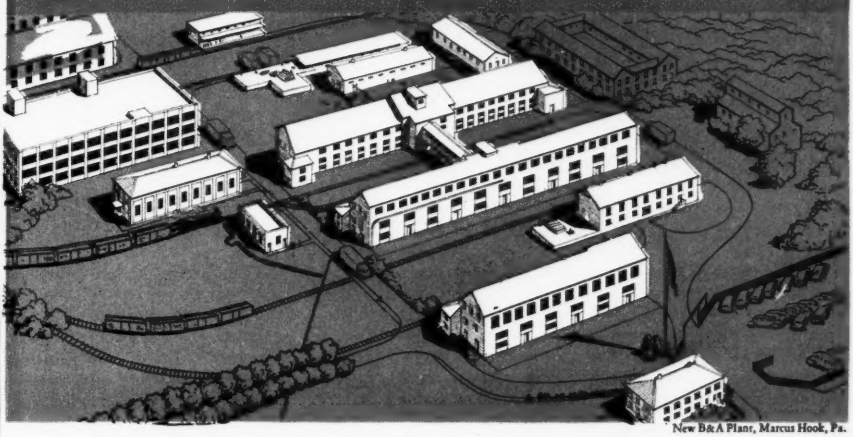
This is an impartial survey of the commercial methods for anodizing aluminum and its alloys. It includes surface preparation and after treatment, such as sealing and dyeing. There will be a short review of the patent situation for the guidance of platers and plant executives. A brief discussion of the technical and physical characteristics of aluminum and its oxide films.

Wednesday Afternoon — June 14, 1944 — 2:00 P. M.

ANNUAL BUSINESS SESSION

Red Room—Hotel Cleveland

AGAIN *GENERAL CHEMICAL* CREATES NEW FACILITIES FOR BAKER & ADAMSON PRODUCTS TO SERVE AMERICAN INDUSTRY!



New B&A Plant, Marcus Hook, Pa.

THESE NEW FACILITIES for production of Baker & Adamson reagent and fine chemicals provide ideal manufacturing areas, additional research and development laboratories, and special storage and shipping accommodations. This plant's output, coupled with that of other Baker & Adamson producing units and distributing stations throughout the United States, marks another forward step in Baker & Adamson leadership

Basic materials for many Baker & Adamson quality products made here come directly from sixteen of General Chemical Company's producing locations. With such fundamental sources of supply, including many Company-owned mines for raw materials, Baker & Adamson is in a pre-eminent and unique position for meeting the expanding uses of high-purity chemicals in industry.

Whether you require laboratory reagents, fine chemicals, or other products prepared in accordance with your formulae—avail yourself of the Baker & Adamson facilities. Experienced technical service representatives are ready to discuss *your* chemical problems and requirements. Baker & Adamson stocks are carried in many principal cities!

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Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

Important Business Session

Election of Officers

Selection of Next Convention City

Adjournment

Wednesday Evening — June 14, 1944 — 7:00 P. M.

BANQUET

Mezzanine Floor—Hotel Cleveland

Banquet, Floor Show and Dancing

Announcements and Awards

(Tables will be reserved for groups which can make up a full table. Stephen Miller, Chairman of Entertainment is in charge of reservations.)

LADIES' PROGRAM

Ladies who attend the A. E. S. Conference in Cleveland will find that a well-rounded program of entertainment has been planned by the Ladies' Committee, of which Mrs. P. Ross Lyons is chairman. The program includes a luncheon and style show on Monday afternoon at the Higbee Company; Aunt Ella's Luncheon, sponsored by Oakite Products, Inc., on Tuesday noon at the Carter Hotel; an evening of games and entertainment on Tuesday evening at the Empire Room of the Hotel Cleveland, and other special features of interest. On Wednesday evening a banquet is scheduled for the Grand Ballroom of the Hotel Cleveland.

The registration fee of five dollars for ladies includes a book of tickets to be used for all events on the ladies' program.

HOBBY AND CURIO EXHIBIT

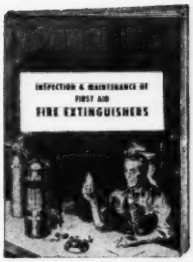
At the suggestion of Vice President Walter L. Pinner, the customary photographic exhibition has been enlarged to include a display of museum pieces sent in by various collectors. They cover some early examples of electroplating equipment, collections of various crystals, a collection of bottles, and many other interesting displays. These groups are not limited to past phases of the industry, but will run all the way from a display centered around penicillin through navigational instruments and many other exhibits the nature of which has not been fully disclosed.

Louis Piovarcy, who is in charge of the details of preparing the displays, states that ample glass enclosed cases will be available, together with blanket insurance and a guard on duty to prevent any harm befalling the displays while on exhibition.

If, when you read this, you think of some curio or item of interest, you still have time to pack it up and bring it with you to Cleveland. It would be advisable to send Mr. Piovarcy a card informing him of your entry; his address is 1029 Pembrook Road, Cleveland Heights 21, Ohio.

Look for this exhibition on the Mezzanine Floor of the Hotel Cleveland and observe what science has done toward streamlining equipment during the past few decades. The exhibition will be open for inspection from morning until night.

FREE BOOK



tells how to be sure your extinguishers are ready!

Your fire extinguishers are *first aid* equipment. They must be ready to nip fires quickly—and that means they must be in top form *at all times*. Regular inspection is the only sure way to keep them in condition.

The booklet shown here has just been issued by Walter Kidde & Company to help you set up a fire extinguisher maintenance system. It covers all types of equipment, gives *specific* instructions. Write for your copy of this free booklet today!

NEW YORK 6, NEW YORK

The electroplating department at Plant 2 of the Nash-Kelvinator Division is well equipped to handle a variety of parts.

Metal Finishing at Nash-Kelvinator

By BRYANT W. POCOCK

THE metal finishing departments of the two plants comprising Nash-Kelvinator's Propeller Division are engaged in the grim business of putting final touches on parts for the well-known Hamilton Standard propeller, which is a far cry from this company's peace-time pursuit of manufacturing automobiles and electric refrigerators.

Each plant is equipped with a complete electroplating department housing a Hanson-Van Winkle-Munning full automatic plating unit and several smaller units. Most of the work on the aluminum alloy blades is done at

Plant 2, where these are finally spray painted in a Binks spray booth and dried by infra-red drying equipment.

At the outset, a great deal of cadmium plating was done, using the conventional 3.5-to-1 ratio of sodium cyanide to cadmium bath. But, in common with most other war plants, Nash-Kelvinator has been obliged to convert to zinc plating, and today this company's use of cadmium is practically nil.

For zinc barrel plating of small parts, a ratio of 2.7 of NaCN to 1 of Zn is used in a bath containing 6 oz. /gal. Zn, 8 oz./ gal. NaOH and 16 oz. /gal. NaCN. This bath is operated at a temperature of 80 degrees F. at 12 volts.

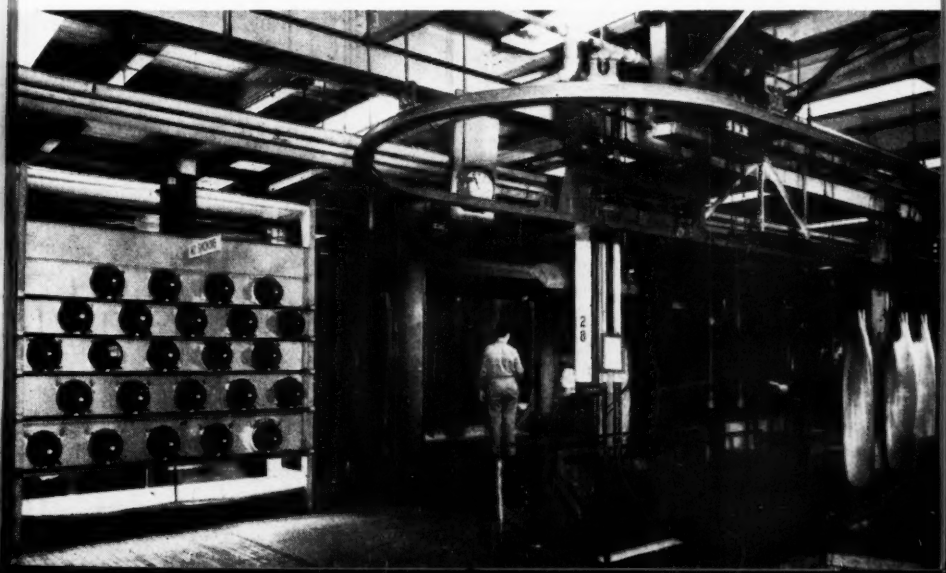
In the automatic, at from 3 to 6 volts, the following bath is used:

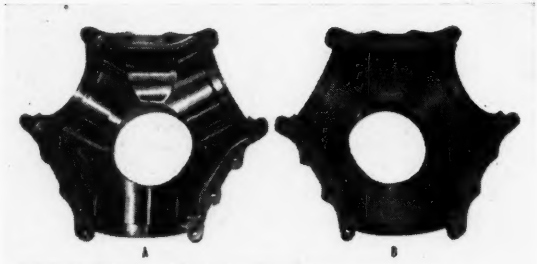
4.5 oz./gal. Zn
11 oz./gal. NaOH
12 oz./gal. NaCN

A current density of 20 to 40 amps./ sq. ft. is used at 70 to 90 degrees F., with both steam and cold water coils immersed in the bath. Here it has been found extremely important to have absolutely no traces of impurities in the zinc, as these, if present, would be harmful to subsequent Iriditing operations by the formation of an undesirable finish. Small traces of impurities are commonly filtered out after precipitation by sodium sulfide. A slight excess of sulfides is always maintained to prevent any impurities from co-depositing with the zinc.

Inasmuch as a zinc plate will corrode in a marine atmosphere, the U.S. Army-Navy specifications designate that zinc-plated parts shall be subsequently treated in such a manner that they will withstand a minimum of 100 hours when placed in a conventional salt spray cabinet. The untreated zinc coatings will not stand up over 24 hours under salt spray conditions without developing white corrosion products and deteriorating rapidly thereafter. After careful consideration of available commercial treatments, Nash-Kelvinator engineers

The aluminum alloy blades for the Hamilton Standard propeller are spray painted and then dried by infra-red equipment.





Shown at the left of this illustration and designated as "A" is the Hamilton Standard "Barrel" before being Iridited; the part indicated as "B" has been Iridited.

eventually decided on the Iridite process to prevent these corrosion products from forming. After Iriditing, zinc plate has been found at Nash-Kelvinator to hold up well for in excess of 500 hours in the salt spray.

Iriditing is essentially a chemical dip, requiring no impressed E.M.F. It is a patented development of Rheem Research Products, Inc., of Baltimore, Maryland, a subsidiary of the Rheem Manufacturing Company. It is used to impart an excellent corrosion resistance to cadmium and zinc-plated parts, and to produce a pleasing olive drab or green color to the finished parts, the intensity and hue of which are entirely controllable by the conditions obtaining during the processing. At both Nash-Kelvinator plants, Iriditing follows all zinc plating, both barrel and automatic. It is set into the Hanson-Van Winkle-Munning apparatus as an integral part of the system. The ultimate color produced can be pre-determined in all gradations from a light blue to a deep, rich brown.

The chemistry of the Iridite process is somewhat involved. According to experts at Nash, it is thought to involve a "chromium-chromate" mechanism, supposedly producing chromous or chromic compounds which, in conjunction with compounds of zinc, act to inhibit the formation of zinc corrosion products. The mechanism is similar in many respects to the inhibiting action of chromium on iron or steel, which for years has

A complete electroplating department is a part of each plant; this view shows the department at Plant 1.

SUN SPIRITS

Steps up Safety 100%

steps down cleaning costs at aircraft plant

Under exacting Government "specs," and at top speed, American manufacturers have succeeded in producing the finest war planes in the world. One aircraft manufacturer, working 'round the clock, solved the problem of washing wings, fuselage assemblies and motors.

Previously, the hazard of fire threatened constantly . . . in addition, objectionable fumes were present, which were irritating to many workmen.

When Sun Mineral Spirits was put on the job, safety improvement was 100%! There were no harmful fumes or ill effects on the workmen.

A saving of ⅔ in costs was also effected by the change, as compared with previous chemicals . . . and, in addition, losses up to 15% were saved in evaporation alone!

This is typical of the performance Sun Spirits is giving in war plants throughout the country . . . helping to speed vital material to our fighting fronts. Your plant, too, can profit substantially by cleaning with Sun Spirits. For further information, write for your free copy of "Case Histories of Cleaning Up War Parts."

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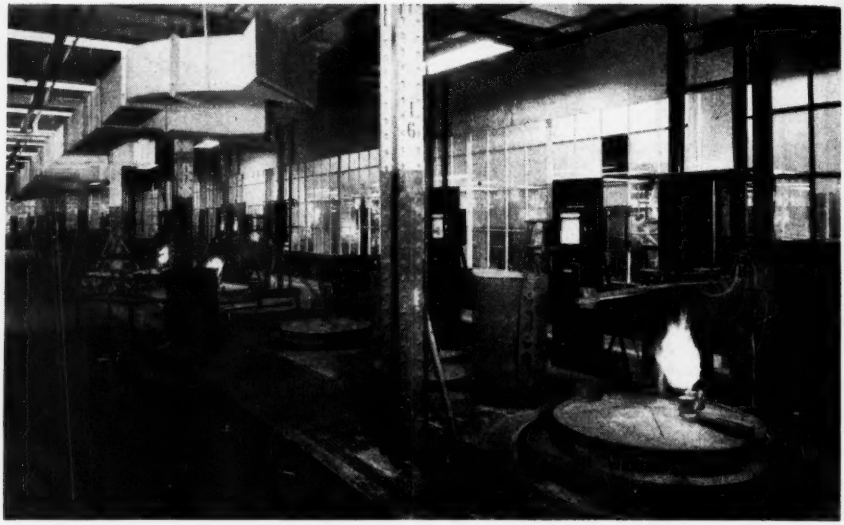
SUNOCO

SUN INDUSTRIAL PRODUCTS HELPING INDUSTRY HELP AMERICA



The carburizing furnaces in the heat treat department of Plant 1 at the Nash-Kelvinator Propeller Division can be seen here.

been one of the best inhibitory reactions known. It has long been common practice throughout the United States, for example, to use chromic acid in steel tanks during hard chrome electrodeposition, where the chromic acid present inhibits the action of the sulfuric acid on the steel. Iridite is known to contain several organic salts along with sulfuric, nitric and hydrochloric acids, plus chromic acid or chromous or chromic salts and possibly alcohol.

Iridited parts are dried by immersion in hot (130 to 145 degrees F.) water followed by a warm air blast. The higher the temperature of this final rinse, the less gloss results in the finished product. In order to obtain the ultimate in gloss, it is necessary to follow the Iridite dip with a thorough rinse in water of room temperature, allowing the parts to dry at room temperature; but it is advisable to flash dry in cases where this process results in streaks. Salt spray resistance has been determined at Nash to be independent of either the gloss or the hue of the finished part. It is the same for all. Paint adhesion, of course, is better with the duller finish.

The Iridited finish has been found to afford much

Three views of the Hamilton Standard "Segment Gear" are shown here: "A", before copper plating; "B", equipped with rubber stop-off mask prior to copper plating, and "C", after copper plating and carburizing.

FREEDOM FROM BURNING!

with the

PROMAT PROCESS

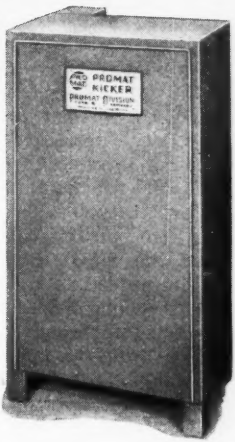
WHEN PROMAT IS ON THE JOB, PRODUCTS WITH RECESSED AREAS MAY BE PLATED WITH PRACTICALLY NO DANGER OF BURNING . . .

The Promat Process provides a wide plating range with resultant freedom from burning at any current density obtainable in still tank, semi, or full automatic.

Promat Zinc No. 90 and Promat Cadmium No. 60 Processes consist of high current density, heavy duty plating baths designed for operation with Promat Kickers which provide alternating current. The alternating current, together with your present direct current, provides the proper asymmetrical wave form. Rates of deposit double those of conventional plating are obtained without the usual operational difficulties present at high currents.

Promat installation is simple and can be accomplished with little effort in minimum time. Promat Zinc and Cadmium Processes using direct current only are also available.

Promat produces unexcelled plating in less time with less effort and cost! Let us prove to you "IT PAYS TO PLATE THE PROMAT WAY."



The Promat Kicker is a single phase, series circuit superimposition unit, designed to provide high amperage alternating current for the Promat Process. The Kicker has complete voltage regulation for the range required by the process, and is a rugged, high safety factor machine. There are no moving parts or other replaceable elements, and the machine will operate for years at its rated capacity.

COMPLETE PROMAT PROCESSES

New and superior Promat Processes for Zinc, Cadmium, Tin, Copper, Nickel and Chrome will be ready for post-war use.

These superior processes are the result of newly developed metallo-organic compounds heretofore foreign to the plating world.

The advantageous use of these compounds with superimposed alternating current sets new high standards of electro-plating.

Promat is capable of providing electro-platers with the means of producing the finest plated products in the world.

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better adhesion to paint than does the untreated zinc coating. Resistance to abrasion is rather moderate, as the Iridited finish will rub off under continued abrasion. On the other hand, this is compensated for by the apparent occurrence of a certain degree of diffusion of the inhibitory action, whereby corrosion of small scatched areas in marine or saline atmosphere is prevented.

Iridite is furished to the trade as Solutions A and B. These are kept separated until the tank solution is made up. Solution A is water white and clear; Solution B is transparent and amber colored. It is mixed in equal parts by volume, IA+IB+8 parts water to yield 10 parts of solution. The correct procedure, according to Nash-Kelvinator experience, is to fill the tank two-thirds full of water, mix in the proper amount of either Solution A or Solution B (not both simultaneously) for the ultimate desired working level, then the other component, and fill the tank to volume with water.

In the automatic, after the zinc plate has been deposited, the parts are immersed in cold running water, then in warm water to bring them up to room temperature or slightly above. This is followed by a 0.5 per cent nitric acid bright dip which immediately precedes the Iridite, the carry-over of HNO_3 having been found advantageous.

When fresh Iridite solution is made up, the pH varies from 1.6 to 1.8. The operating pH should be from 2.0 to 3.0. To raise it to the proper level, the addition of zinc oxide has been found efficacious. In practice, it has been found convenient to determine the quantity of ZnO necessary per gallon of solution to bring the pH up by one point, using this as a basis for further additions if necessary.

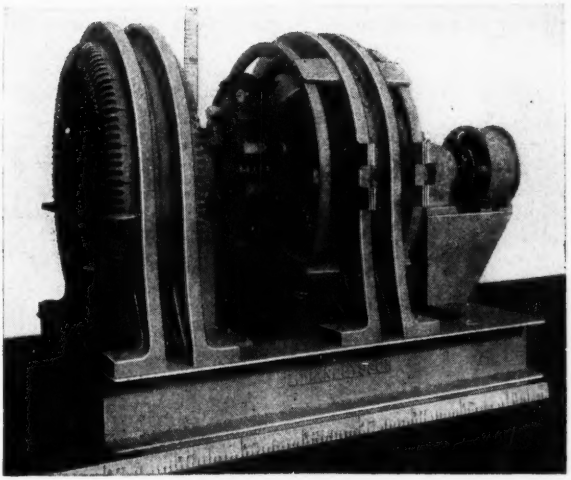
Zinc is very slightly dissolved in the Iridite, in amounts not detectable by ordinary means, forming a basic effect on the Iridite and raising the pH. But at the concentration in which the carry-over of HNO_3 occurs, the latter will not completely counteract the basic effect of the dissolved zinc, as is evidenced by the fact that the pH continues to rise as the solution is used. In maintaining a working pH of 2 to 3 by further additions of nitric acid, as is done at Nash-Kelvinator, the solution gradually becomes depleted in chromic salts. Although in this instance the pH is within satisfactory limits, the color of the Iridited parts gradually fades and cannot be restored unless equal parts of A and B are added in requisite amount.

Therefore, it has been found advisable to have the laboratories check trivalent chromium after one day's operation of a new Iridite dip, along with pH and hexavalent Cr, and to keep these figures as the basis for a standard. There has always been very little trivalent Cr left after the first day's operation.

On continued use, the iridite solution changes from a dark amber to a light green, and finally to a dark green with the formation of increasing amounts of precipitate. This sludge is not harmful in any way, except by its mechanical presence, which in time may prevent proper circulation of the fluid about the parts. Being an inert by-product, it is considered worthless and may be discarded by decantation if desired. The dark grass green color is due to trivalent chromium build-up, along with other salts of chromium.

It has been found advisable to have moderately vigorous agitation in the Iridite bath, air agitation being the most convenient. In an automatic system, with limited timing, the two factors controlling the color of the finished part are temperaure and concenration. By concentration is meant that the proportions of Solution A to Solution B to water may be varied so that IA+IB+$6H_2O$, for example, will

WHILE THEY LAST



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work on the zinc coating as a more concentrated bath than that previously mentioned (1:1:8). Experience at Nash has demonstrated that it is not necessary to vary the concentration, as a temperature of 80 degrees F., an immersion of 20 seconds, adequate agitation, and a pH of 2 to 3 will maintain proper coloring of the parts if the chemical constituents of the bath are well balanced.

Daily addition of reagents (A, B, and HNO_3) to maintain pH, depending as it does on the plated area being Iridited per day per gallon of solution, is empirical and must be determined through experience. Air agitation should be introduced into the bath on both sides of the parts, with separate controls on each side. Although air is preferable, live steam can be used. Rubber nozzles are advisable for the air jets.

There is no heat whatever from the chemical reaction, it being neither endothermic nor exothermic to an appreciable extent. If as time goes on, the coloring of the parts suddenly changes to a light olive green, it has been found expedient to check in order (1) the pH, (2) the chromium content including the trivalent, (3) the air agitation, which may be too severe, and (4) the rinsing water, which may be too hot.

While a freshly Iridited part is in cold water, the film is gelatinous and may easily be removed by rubbing. The hot water rinse helps harden the film more rapidly. The tank containing the Iridite bath should be made of (1) Tygon, (2) lead, or (3) ceramic material (brick).

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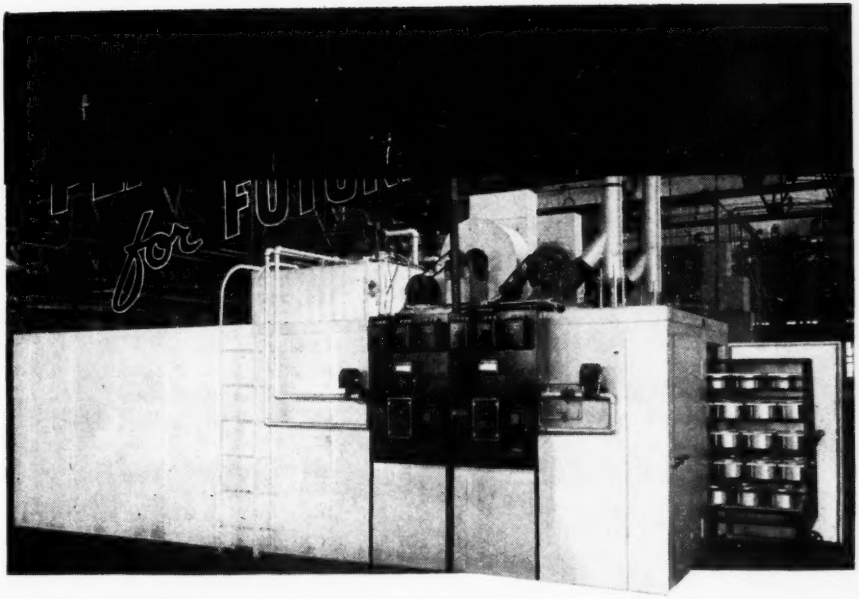

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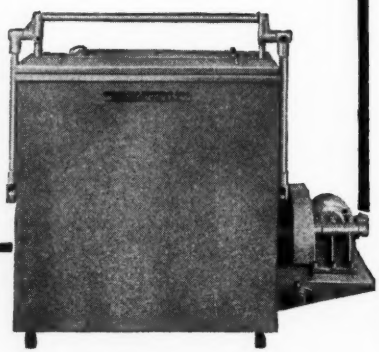


automatic plating unit is operated on 6 volts at the Nash plants and includes 18 treatments, as follows:

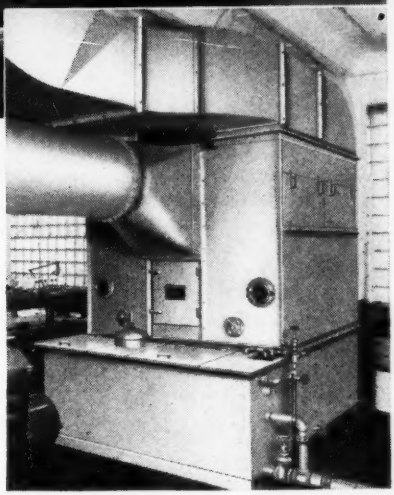
1. 5 oz./gal. alkali cleaner with direct current at 190 degrees F. Time: 3 minutes.
2. Same as (1) with reverse current.
3. Cold water rinse.
4. 10 per cent H_2SO_4 at room temperature.
5. Cold water rinse.
6. Same as (2).
7. Cold water rinse.
8. 50 per cent HCl at room temperature.
9. Cold water rinse.
10. 3 oz./gal. NaCN, direct current.
11. Cold water rinse.
12. Zinc plating bath (see above).
13. Cold water rinse.
14. Cold water rinse.
15. 0.5 per cent HNO_3 at room temperature.
16. Iridite bath (see above).
17. Cold water rinse.
18. Hot water rinse (170 degrees F.).

All plating solutions are analyzed by the laboratories for metals, pH, and so on, twice weekly; cleaning solutions, rust preventative solutions and acid pickles are analyzed twice a month.

For nickel plating, the formula of International Nickel Company's W. A. Wesley is used, primarily for salvage of undercut parts. The characteristics of this bath are as follows:

40 oz./gal. nickel chloride
4 oz./gal. boric acid
pH=2
T=140 degrees F.
Current density = 20 to 50 amps./sq ft. unagitated
= 100 amps./sq. ft. agitated.

Hydrogen peroxide is added to this bath to control pitting. The cathode efficiency is 97 per cent as compared with only 13 to 15 per cent in the case of hard chrome. At 50 amps./sq. ft. the rate of deposition of Ni is 0.0024



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inch per hour.

By use of Wesley's formula a good, serviceable deposit of nickel is obtained of 25 to 27 Rockwell C hardness. With the expenditure of less than 10 pounds of nickel, Nash-Kelvinator engineers have saved their company thousands of dollars in salvaged parts. A high melting point (180 degrees F.) wax is used as a stop-off which on repeated immersion of the part is built up to a ¼-inch layer, the area to be plated being bared with a knife. The wax is subsequently removed with an organic solvent. Prior to nickel plating, the parts are electrolyticly alkali cleaned. In order to obtain adequate adhesion, it is mandatory to etch the part anodically in 10 per cent H_2SO_4.

For chromium plating, the conventional 100-to-1 bath is used, calling for 40 oz./gal. of CrO_3 and 0.4 oz./gal. H_2SO_4 at a temperature of 130 degrees F. and a current density of 3 amperes per square inch. Considerable hard chromium is used on drills, reamers, and other small tools, the pH not being controlled. The only cleaning prior to plating is a degreasing operation.

Selective carburization of segment gears used in the Hamilton Standard propeller is accomplished at Nash-Kelvinator's Plant No. 1 using a copper plate carburizing stop-off. The thickness of this copper coating is held between the limits of 0.0010 to 0.0012 inch. Whereas many operators have experienced difficulties caused by carbon penetrating a plate of this thickness, this has not been the case at Nash. A current density of 25 amperes per square foot has been found to yield a fine deposit with the following bath:

3.5 oz./gal. copper cyanide
4.5 oz./gal. sodium cyanide
2 oz./gal. sodium carbonate
5 oz./gal. Rochelle salts
pH = 12.6 0.2 or —0.4
T=140 degrees F.
Voltage=3 to 4 volts.
Current density=25 amps./sq. ft.
Anode=rolled copper.

With this bath it takes 40 minutes to produce the 0.001-inch plate. Rubber masks which have been found convenient and economical, are used as plating stop-offs.

For the removal of Magnaflux paste, parts are run through a large Detrex washing machine containing 1 part of Triad 93 to 50 parts of water in the wash side and 1 of Triad to 75 of water to the rinse side, at a temperature of 190 degrees F. This mixture of Triad in the rinse side has been found to afford more adequate rust prevention than neat water. Depending on the tenacity of adhesion of the paste particles to the parts, a few-seconds pre-dip to a 3-minute soak in a mixture of 50 per cent kerosene and 50 per cent Triad by volume is given the parts prior to the washing machine operation. The red paste adheres more strongly and is more difficult to remove than the black paste. The parts take from two to three minutes to pass through the washer, after which they are blown dry with an air blast.

Triad 93 has also been found very successful in 1-to-50 mixture with water for boiling out and cleaning "sour" degreasers. An important advantage is that very little washing with water is required to remove the Triad. Oily scale is completely removed in this manner. It has been found convenient to run the grates of the vapor-type degreasers through the automatic washer to remove the heavy, semi-oxidized oil residue which results from continued degreasing operations.

For some time Nash-Kelvinator scientists have been experimenting with techniques of sand and shot blasting steel parts after coarse grinding, and have been able to produce excellent surfaces for plating and

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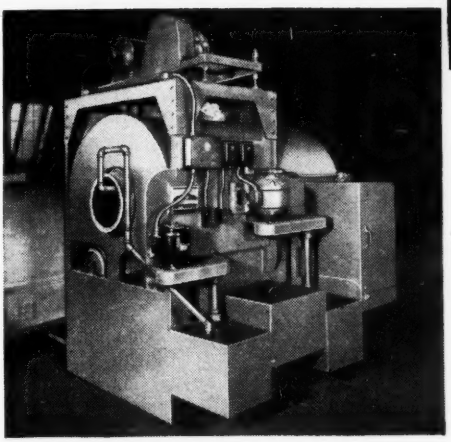

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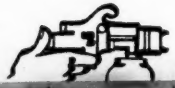
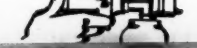


No drying equipment *is needed, with its high initial cost, con-*

Their *color range* will be *unlimited*. They will still be tough,



No drying equipment *is needed, with its high initial cost, con-*

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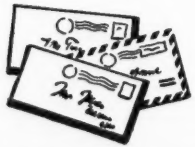

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other subsequent operations, thus eliminating considerable manual work. Apparently the very act of polishing has been found to produce an overheated surface condition, which in turn gives rise to undesirable tensile stresses at the surface. This condition can be prevented or even remedied, according to Almen (1) and (2), by impact blasting, which results in the formation of compressive stresses and a correspondingly increased life expectancy for the parts. In fact, Nash-Kelvinator now plans to use shot blasting in the taper bore of the aluminum blade (X76S alloy) to overcome tensile stresses introduced by the heat treatment of the blade.

Both plants of the Propeller Division have well-equipped laboratories staffed by experts who, in addition to their routine duties, have found time to do considerable work of an investigational character, much of which has been in the field of metal finishing. A great deal has been done on the reclaiming of abrasive discs after the latter have become clogged with aluminum, on the electrolytic polishing of metals, on improved methods of analysis, on etching problems, plating problems, and similar subjects.

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(1) Almen, J. O. *Shot Blasting to Increase Fatigue Resistance*, General Motors Corp., Research Laboratories Division; SAE War Material Meeting, Detroit, June 9, 1943, and Natl. Aeronaut. Meeting, SAE, New York, April 8, 1943; SAE Journal Transactions, Vol 51, No. 7, p. 248, July, 1943.

(2) Almen, J. O., *Peened Surfaces Improve Endurance of Machine Parts*, Metal Progress, p. 209, February, 1943.

Lima Magnetic Polishing Lathe is the subject of an eight-page engineering and data bulletin released by The Lima Electric Motor Co., 176 Findlay Rd., Lima, Ohio. The bulletin explains in detail the principle of operation of the unit and is illustrated to show the method of application of the magnetic chuck. It also illustrates several different types of faceplate applications for holding work to be polished, burred, or lapped. Copy free upon request.

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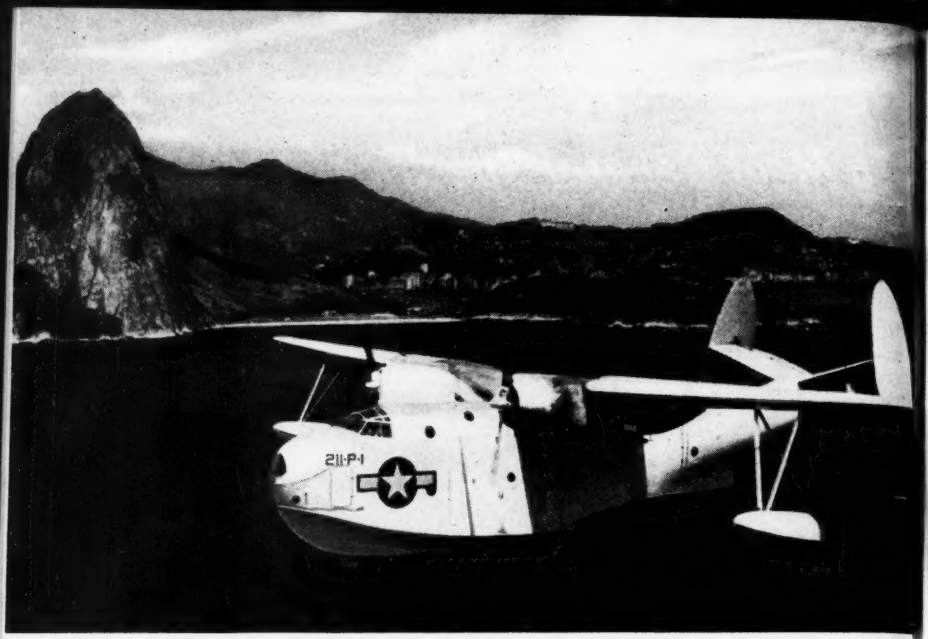


Improving Zinc Chromate Primer Adhesion

By J. F. MASON
Chief Materials and Process Engineer
The Glenn L. Martin Company

THE use of zinc chromate primer on airframes currently produced for Army and/or Navy service is required for the corrosion protection of all metals and alloys used in aircraft manufacture. In the majority of cases all non-corrosion resistant steels and copper alloys are cadmium or zinc plated and the plating deposits neutralized, the aluminum alloys anodized, and magnesium alloys surface treated by the dichromate treatment or another approved process, before the primer is applied. These processes serve the dual purpose of offering additional corrosion protection and promoting primer adhesion.

After the metal has been processed inorganically in accordance with existing service requirements, the detail parts are coated as soon as possible thereafter with one coat of zinc chromate primer to avoid contamination of the metal surface. The maximum thinning ratio of primer is in the proportion of one part of primer to three parts of thinner for dip application, and one part of primer to two and one-half parts of thinner for spray application. These applications result in an average coating thickness of

one-half a mil (0.0005 inch), which is adequate for corrosion and abrasion resistance during subsequent shop fabrication. The process for the application of zinc chromate primer is given in Navy Aeronautical Specification No. PF-9C.

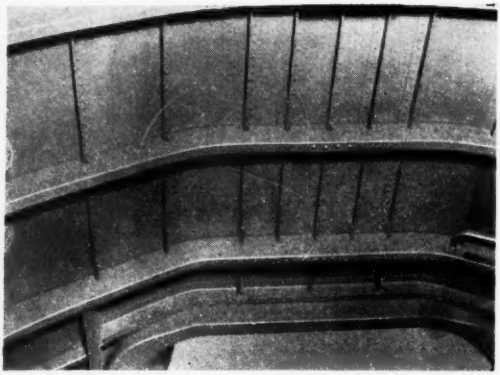
The thickness of subsequent primer coats is not additive, since additional coats applied soften and penetrate into the preceding primer coat to some extent; thus, the thickness of three coats of zinc chromate primer would be more in the nature of 1.0 mil (0.001 inch) than 1.5 mils. This may be compared to the thickness of one coat of lacquer which is approximately 1 mil.

The color of zinc chromate primer lends itself to visual inspection; for example, the color of a primer coat applied in the correct thickness of one-half a mil is a greenish-yellow. This color increases to a greater degree of yellowness as the film thickness is increased by additional coats applied. The hiding power of primer is relatively poor when applied in the correct thickness of one-half a mil, but it increases as the film thickness is increased. It should be remembered, however, that primer is applied for the corrosion protection of the metal on which it is coated, since it forms soluble chromates when in contact with water. It is not intended for hiding; in fact, heavy coats of primer have a detrimental effect, since they tend to become brittle, crack and have poor metal anchorage.

The most common reason for lack of zinc chromate primer adhesion to anodized (or equivalent) aluminum alloys or other metals is improper cleaning prior to finishing. The surface of the metal must be free of foreign matter in order to obtain the proper film anchorage. Cleaning materials which have a deleterious effect on the metal or which leave a deposit or waxy film on the surface should not be used. An additional operation will be required to remove deposits remaining on the metal surface in order to attain maximum paint adhesion.

The author believes that a mixture of hydrocarbon solvents, such as toluol or xylol and alcohol in the ratio of two parts to one, are most effective for the cleaning operation. This mixture flashes off the surface quickly and leaves no residue, and the alcohol content is sufficient to remove any moisture present. This mixture may also be used for cleaning primer prior to application of final finish, since it will not remove the hardened primer without continuous rubbing. It will soften the surface of the first primer coat and will tend to promote adhesion of the subsequent primer or finish coat. Precautions should be taken to insure that the cleaning mixture does not contact the skin of personnel for long periods of time, since in some cases a dermatitis may result from prolonged contact with the xylol in the cleaning solution.

When zinc chromate primer is applied to anodized aluminum alloy, 24ST alclad, parts in detail, as a shop protective coat to prevent abrasion of the soft 2S aluminum coating during storage and fabrication, the primer dries very hard before subsequent finish coats are applied. The degree of primer hardness depends almost entirely on the length of time the parts remain in stock or in sub-assembly. However, with methods used in current production, there is usually a time lapse which is sufficient to permit the resins in the primer to polymerize completely. In this case, the primer film has a hard glazed surface and it is very difficult to remove the primer if a stripping or partial stripping operation is to be accomplished. The high temperatures sometimes encountered during the summer months and in southern areas will increase the rate of primer polymerization; therefore, adverse outside storage con-



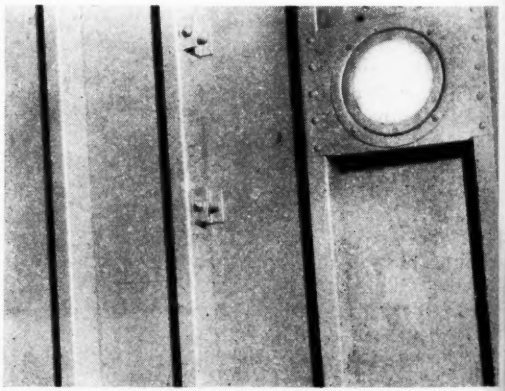
An example of good second primer coat adhesion on the ceiling of the aft officers' compartment in the Martin PBM-3 Mariner.

ditions should be avoided.

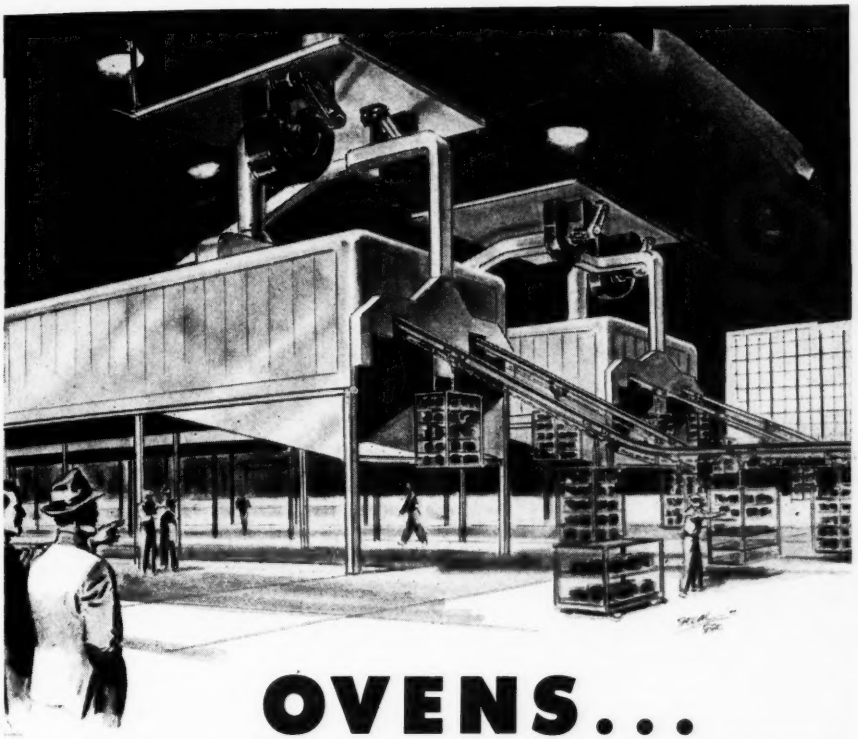
It is common practice, in present-day airframe manufacture, to prime detail parts by automatic spray machine, hand spray or dip application. After priming, the usual sequence of operations is as follows. The detail parts are drawn from stock as required, fabricated into sub-assemblies, and these sections are riveted together to form major assemblies. The airframe, after completion, is cleaned in the final assembly section prior to the application of the final finish coats. A cleaning crew removes all dirt, oil, grease, superfluous sealing materials and foreign matter by means of a thorough wash down with hydrocarbon solvents, and vacuum equipment is used in conjunction with this procedure to remove chips, lint, paper, and so on, from the interior of the ship. Immediately after the cleaning operation, a second or touch-up coat of zinc chromate primer is applied by spraying to cover bare spots, rivet heads, and so on. A complete spray coat is applied because it is easier to spray overall than to touch-up by brush with potential danger of primer runs or to spray only bare spots or abraded areas with consequent difficulty with dry overspray.

Trouble, if any, is usually encountered at this point. The detail coat of zinc chromate primer is usually very hard and, unless the film surface is scuffed or abraded slightly to provide a roughened surface or "tooth" for the second primer coat, the adherence of the second primer coat will be very poor. (Note: In some cases a partial stripping operation must be performed to insure second primer coat adherence. The author believes, as stated, that in this case the detail primer coat has polymerized completely and cannot be softened by the hydrocarbon cleaners or the zinc chromate primer thinners.)

The cleaning operation is usually accomplished by means of cloths



In the lower right hand section of this illustration can be seen respray on areas of poor second primer coat adhesion.



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dampened with hydrocarbon solvent, which are used to rub and wipe down the primed surfaces. This method is satisfactory for second primer coat anchorage provided that the detail primer is not hardened throughout and the oxidized surface film is abraded sufficiently. There is a natural tendency, however, to concentrate on the areas which are soiled and to wipe over lightly the overhead areas which do not accumulate dirt or grime. These areas usually constitute the under surfaces of floors, decks or hull crowns, and consequently these are subject to flexion because of sustained

The portion of the ceiling shown here clearly indicates poor second primer coat adhesion.

traffic during ship assembly. This flexure will indicate the degree of second primer coat adhesion, and poor anchorage becomes evident in a short time. Scotch masking tape may be used to test adhesion. The tape is simply pressed firmly against the primer to be tested and pulled off quickly. If primer adheres to the tape, the anchorage is unsatisfactory. This test should not be conducted before the primer has dried at least 24 hours.

The tedious cleaning and scuffing operation necessary to break down the hard glazed surface of aged zinc chromate primer has been alleviated by the use of aluminum wool. This soft material, when used in conjunction with hydrocarbon solvents, will penetrate the hard primer surface rather readily. It will not abrade the anodic (aluminum oxide) film on the surface of the metal and, thus, is foolproof in that it eliminates this potential hazard. The total area of the wool strands or fibers is sufficient to retain enough of the cleaning solvent for efficient cleaning and softening of the primer as the wool cuts through the finish. The detritus remaining on the surface of the primed metal is easily removed with a clean cloth dampened with cleaning solvent.

there. The particles of wool is indicated in cases where a complete stripping operation is specified. This material will strip primer and air-dry enamel or lacquer with equal facility; and, since copious amounts of solvent are not necessary as in hand cleaning, it tends to prevent seepage into sealed seams with consequent deterioration of the sealing materials incorporated there. The particles of woo. which might remain in the ship will not be detrimental from a dissimilar metal standpoint, since only 2S, 3S, 52S, or 56S aluminum wool is used. Pure aluminum and these alloys have good corrosion resistance.

The cost of the aluminum wool versus the time required for a normal cleaning operation by means of cloths dampened with solvent and fiber brushes has been studied. The results of this investigation indicate that the cost of the wool is offset by a saving in cleaning time, an increase in clean- efficiency, and the insurance of excellent film anchorage.

Two alternate methods of promoting adhesion of a second coat of zinc

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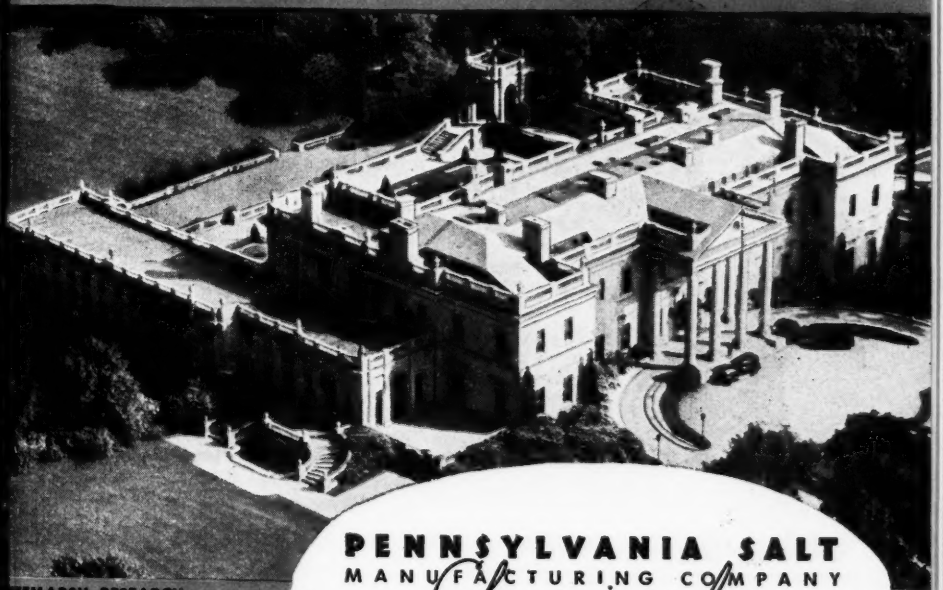

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chromate primer to an aged detail primer coat have been tried experimentally with good results. At present, however, there are no test results available in regard to the anchorage of film applied by these methods after a six-months' aging period. The two methods are: (1) to apply a very thin intermediate coat of zinc chromate primer (90 per cent thinner —10 per cent primer) to the detail coat, or (2) to apply a sizing coat of hydrocarbon solvent plus two per cent of phenolic varnish (Navy Specification V-13) added. In both methods, the intermediate coat is applied to the detail primer coat after the cleaning operation has been accomplished.

In conclusion, it is reiterated that maximum zinc chromate primer adhesion can only be obtained by application on metal surfaces which have been cleaned thoroughly. In the case of subsequent primer or final finish coats applied over an aged detail primer coat, it is very important to abrade or scuff the hardened primer to insure a good bond. The use of aluminum wool is recommended for this operation.

Correction

In the article "Classification of Pigments" published in the April,1944 issue of PRODUCTS FINISHING, the captions were inadvertently reversed on two illustrations. The caption under the cut on page 38 should read, "An example of a nodular or spherical type of pigment." The caption under the cut on page 50 should read, "An example of an acicular or needle-shaped type of pigment."

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Corrosion-Resistant Materials

in Pickling, Cleaning and Plating Operations

By EDWARD ENGEL
Consulting Engineer, Colonial Alloys Company

DEFINITE remedial conclusions have not been developed for all complex corrosive conditions. However, an appreciation of the corrosion factors and forms, together with an understanding of chemical resistant materials, will aid in combating corrosion in pickling, cleaning and plating operations.

The corrosion factors are as follows:

(1) Metals are corroded by: acids, natural waters, chemical salt brines, air, oxidizing agents, electrolytic effects, soil, high temperatures, movement, films, organic materials, eddy currents, alkalies, sulfur compounds.

(2) The usual forms of corrosion are: direct chemical, pitting, galvanic or two-metal-cell, dezincification, concentration or solution cell, and corrosion cracking or fatigue corrosion.

(3) The properties of metals which determine the rate of corrosion are: chemical affinity, composition, strain, surface, and corrosion product (film) properties.

(4) The classification of metals as to their tendencies to corrode may be expected to follow the solution potentials shown on Table I. This table has a general analogy with the Electrochemical Series, although it is believed that Table I indicates the more practical sequence, as it takes into consideration the natural oxides on the light weight alloys.

SOLUTION POTENTIALS MEASURED IN SODIUM CHLORIDE SOLUTION

TABLE I

Metal or Alloy	Potential in Volts
Magnesium	— 1.73
AM3S-Mg Alloy	— 1.71
AM57S—Mg Alloy	— 1.68
AM240—Mg Alloy	— 1.66
AM265T-4 Mg Alloy	— 1.63
Zinc	— 1.10
220T-4-A1	— 0.96
56 SO	— 0.87
52 SO	— 0.85
2S, 3S, 53 ST, 61 ST, 43	— 0.83
Cadmium	— 0.82
356T-4-A1	— 0.81
355T-4-A1	— 0.78
195-T-4-A1	— 0.70
17 ST, 24 ST	— 0.68
Mild Steel	— 0.67
Lead	— 0.55
Tin	— 0.49
Brass (60-40)	— 0.28
Stainless (18-1)	— 0.28
Copper	— 0.20
Stainless (18-8)	— 0.15
Monel	— 0.10
Silver	— 0.08
Nickel	— 0.07

The metal which is anodic (listed relatively higher in Table I) to another metal, in a two-metal-cell (galvanic couple) tends to corrode, although metals close together have no strong tendency to form active galvanic couples. The metals and alloys, as shown in Table I, indicate their tendencies to corrode, and are in proportion to the potential differences between two metals, when coupled together in the presence of a conductive solution or medium.

Complex Factors of Corrosion

Of the 14 factors listed as causes of corrosion, a few are not sufficiently defined by their names and involve more complex reactions; also, in some instances, some factors have reverse or opposite reactions. Therefore, explanations of the complex and reverse reactions are presented as follows:

(1) Aeration: Certain corrosive agents will corrode some metals with increased rates in the presence of dissolved air. This type of accelerated corrosion may be more noticeable at the solution line of a metal container; or it may occur at greater depths due to aeration of the solution, such as caused by agitation. Monel, for instance, is dissolved over 90 times more rapidly in a thoroughly aerated 2 per cent sulfuric acid solution than in the air-free solution.

Opposite results occur when certain metals are in aerated solutions: i.e., the rate of corrosion is retarded. This passivity or cathodic effect of the increased oxygen content of a solution occurs with certain metals, particularly with aluminum and 18-8 stainless steels.

(2) High temperature may increase or decrease the rate of corrosion; in some solutions this rate of corrosion is accelerated from two to four times for each 50 degree F. rise in temperature. Local differences in solution temperature tend to create concentration or solution cells. Temperature is very important in its effects on the formation and solubility of films. In some solutions a metal which is dissolved at low temperatures becomes passive at higher temperatures due to the formation of a protective film. The reverse action—i.e., film formation at low temperatures and film solvency at higher temperatures—is of more usual occurrence.

(3) Films: As a corrosion factor, films may accelerate or may retard corrosion. Certain metals, although initially attacked, resist progressive corrosion if the products of corrosion (films) are adherent and insoluble in the solution under conditions which created them. Thus lead serves satisfactorily as the anode in chromium plating baths; the film formed on the lead is adherent, continuous and insoluble in the chromic acid solution.

An opposite effect (i.e., an accelerated rate of corrosion) may be caused by the formation of uneven films on certain metals. An uneven film may expose the basis metal to the solution and thus form a galvanic couple (electrolytic effect) with the film, causing an increased rate of corrosion.

(4) Electrolytic effects: As a corrosion factor, the coupling of two dissimilar metals in the presence of a conductive solution tends to dissolve the metal which is more anodic (see Table I).

Even the potential difference between an annealed area and a strain-hardened area of the same metal may be sufficient to cause the more annealed (more anodic) area to be dissolved. A copper or aluminum vessel may be corroded, unless the entire vessel is hand hammered after fabrication. The hand hammering results in presenting nearly equal strain hardening throughout the vessel.

In some instances two dissimilar metals are galvanically coupled in or-

der to protect a metal tank from corrosion. Thus, a relatively small area of aluminum coupled with a steel tank used for corrosive waters, and a small area of zinc coupled with an aluminum tank, will protect these tanks from corrosion. The small areas of aluminum and zinc are preferentially dissolved, for in each instance they are anodic to the respective tank metal.

(5) Eddy currents of electricity: Tanks linings which are otherwise suitable may be corroded by stray or eddy currents. Eddy currents occur in tanks containing plating solutions under impressed voltages, and such stray currents effect corrosion on conductive linings when the voltages are sufficiently high. Such an instance occurs in alterating current anodizing processes; the high operating voltages and the inductive property of alternating current create sufficient eddy currents to accelerate the corrosion of lead linings, as compared to the passivity of lead lining in anodizing processes employing (non-inductive) direct current at lower voltages. Plating processes employing a.c. superimposed on d.c. may create sufficiently effective eddy currents to make the use of non-metallic linings advisable.

(6) Movement, such as caused by agitation, pumping and filtering operations, is a corrosion factor as it may create: (a) concentration or solution cells, (b) aeration, (c) errosion, or (d) movement may also effect film formation.

Complex Forms of Corrosion

The various forms of corrosion which may require defining are:

(1) Corrosion cracking or fatigue corrosion refers to the tendency of an increased rate of corrosion at areas of metals in a stressed condition.

(2) Dezincification refers to the corrosion effect of a solution in dissolving any constituency of a metal, as may occur with brasses and aluminum alloys and other metals.

(3) Concentration or solution cells occur as a corrosion factor under several conditions, of which two are of importance in plating room operations. Metal may be corroded when it is surrounded (a) by a more dilute portion of the solution, or (b) by a part of the solution containing less oxygen than surrounds other areas of the same metal. Local differences in temperatures and movement are two important causes which create differences in solution concentration and aeration.

Two or more corrosion factors and forms of corrosion may occur simultaneously which makes a slide rule type of conclusion difficult to formulate. Unlooked for or even paradoxical reactions occur in more than a few instances.

An instance of a paradoxical action, or at least an unexpected one, occurs when pieces of cotton fabric are immersed in a sulfuric acid anodizing bath operating with alternating current. Cotton fabric may be attached to one or both aluminum electrodes being anodized and as long as the current is on, in the regular anodizing cycle, no attack occurs on the cotton fabric; but when the circuit is open, an immersion in the sulfuric acid electrolyte for an equal length of time results in the subsequent disintegration of the fabric.

Corrosion-Resistant Metals and Structural Materials

Wood has excellent resistance to neutral and acid salt solutions, hot or cold. It is also suitable for use with many organic solutions and dyes. Cypress and pine wood are about equally resistant to chemical solutions. Pine has about 5,000 p.s.i. tensile strength, which is about 20 per cent stronger than cypress, but cypress is more available.

Low carbon steels are suitable for the following: most concentrations of

hot or cold alkaline solutions, rinse solutions, solvent degreasing solutions, neutral salt solutions, cyanide and other alkaline plating electrolytes, chromic acid anodizing electrolytes, magnesium anodizing electrolytes, chromium plating solutions, aniline dye solutions, and solutions used for sealing anodized aluminum and magnesium. Steel tanks of ⅛-inch thickness for smaller tanks, and with ¼-inch gauge for large tanks, are most usual.

Commercial aluminum is a satisfactory choice for tanks, linings, piping, and so on, in handling stearic, tartaric, citric and nitric acids, sodium sulfate, ammonium nitrate, hydrogen peroxide, cellulose acetate, synthetic resins and formaldehyde. For anodizing racks, 17ST aluminum is usually used.

Chromium-iron, containing 25 to 30 per cent chromium, is available in most forms; it is one of the best metals for use with hot or cold nitric acid.

Copper is resistant to stearic acid, very dilute sulfuric acid, and high concentrations of caustic soda. Copper containing 1 to 5 per cent and 1 to 2 per cent manganese (or tin, or zinc) is of interest in that it has high resistance to HCl (hydrochloric acid). A copper-silicon alloy has excellent resistance to salt water.

Aluminum-bronze, although seldom used in pickling and plating equipment, has high strength and is resistant to cold or hot H_2SO_4 in concentrations from 5 to 77 per cent.

Cast iron, containing around 14.5 per cent silicon, serves well for all concentrations at all temperatures for the following acids: sulfuric, nitric, acetic, phosphoric, citric, and tartaric. It is also satisfactory for cold hydrochloric acid, Silicon-iron pipe and lined pumps, valves and other applications are common in plating rooms. Silicon-iron containing molybdenum withstands hot hydrochloric acid.

Chemical lead and the stronger and harder antimonial lead are widely used in plating rooms. Lead provides serviceable resistance up to 95 per cent H_2SO_4 at room temperature, and withstands up to 60 per cent concentrations at a boiling temperature; it is also suitable for hydrofluoric acid solutions. Lead is the most used lining in plating room tanks. Lead tank linings of four-pound weight per square foot serve for nickel and similar electrolytes. Acid copper solutions require six-eight pound lead, while stronger electrolytes call for eight-ten pound lead. Lead-covered steel, iron, copper and brass, for pipes, valves, sheet and fittings, are also available.

"Monel" metal is resistant to many chemicals, acids and alkali solutions. One of its chief uses in plating rooms is in vapor degreasing machines, due to its resistance to chlorinated solvent vapors. Monel is also found in platers' filter presses and baskets.

"Hastelloy A" (a nickel alloy) is available in most forms and is considered one of the best commercial alloys for resisting strong hydrochloric acid at temperatures up to 160 degrees F.

"Ilium G" (a cast nickel alloy) has excellent resistance to all concentrations of sulfuric acids up to boiling, and resists 0.5 per cent to 100 per cent nitric acid up to 100 degrees F.

Stainless steels (18-8) are satisfactory for use with nitric acid in all concentrations at all temperatures, and for use in chromium plating tanks. It is NOT resistant to sulfuric acid solutions.

Chemical stoneware is available for containers in various sizes up to 600-gallon rectangular tanks, although its most popular sizes are up to 50 gallons. It can be depended on to resist about any corrosive agent except hydrofluric acid and fluorides. Ceramics are also available in piping, cocks, faucets, fittings, and pump linings,

dipping baskets, and so on.

Glass enamel on steel, fused silica, quartz and borosilicate glass (Pyrex), with the exception of HF, flourides, and in some instances caustic solutions, resist most other corrosive agents.

Corrosion-Resistant Flexible Linings

Natural rubber, chlorinated rubber and other rubber-like products combined with plasticizers, or with resins or pigments, present suitable properties, especially for use with sulfuric, hydrofluoric and nitric acids. Hard rubber bonded to soft rubber is an effective protection against hydrochloric acid at temperatures up to 180 degrees F. Some of the synthetic rubber-like products are more resistant to certain corrosive agents than others; for instance, one withstands copper chloride, chromic acid, calcium bisulphide, nickel acetate and silver nitrate. In the soft condition, rubber-like materials are used up to 150 degrees F.; in the hard condition, the limit of operation is 190 degrees Fahrenheit.

The phenolic resinoids, urea, vinyl, cellulose nitrate, ethylene and styrene resin derivatives, cellulose acetate, ethyl acetate, soybean and other synthetic resins, have applications as protective coatings. Different types of phenolic resinoids are resistant to most chemicals, including HCl, HF, HF mixtures, and fluorides, but they are not resistant to hot sulfuric acid, concentrated alkalies, and organic bases. These materials are operative up to 130 degrees F.

Corrosion-Resistant Rigid and Brick Linings

Carbon brick is inert to nearly all acids, including HF, at all temperatures and concentrations, with the exception of strongly oxidizing chemicals like chromic and nitric acids and ferric sulfate. Tempered glass is effective for most corrosive agents, except HF and fluorides. Chemical brick is a generic term and may include anything from burnt common brick to carefully washed clay. Hard burnt, salt-glazed, shale brick is the best chemical brick for most purposes. Chemical brick serves satisfactorily for acid-resistant flooring and drains, as well as for tank lining for practically all plating room solutions except HF acid and caustic solutions.

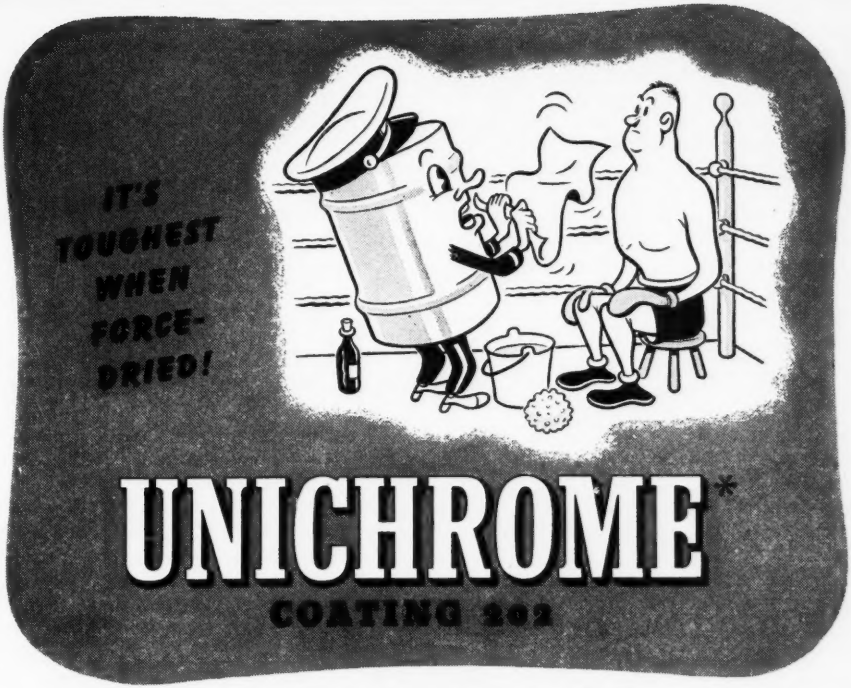
The use of two or more staggered courses of brick is considered the best protection against possible seepage due to porosity or faulty cementing. In all applications of brick, the tank material of wood, concrete or steel is treated with a suitable cement before laying the brick course. Steel tanks do not require scraping prior to cementing; if a concrete tank is used, it is washed with a 3 per cent HCl solution and rinsed. Bricks of the chemical type need no pre-cementing preparation unless they are acid-saturated, in which event they are neutralized with a wash of 5 per cent caustic soda. Concrete and wood tanks are generally cemented with asphalt, and steel tanks with sodium silicate cements of from $\frac{1}{16}$ to $\frac{1}{8}$-inch thickness before laying the brick.

Forces set up by expansion and contraction must be guarded against. Sudden temperature changes in excess of 4 degrees F. per minute are hazardous to brick lining and cements.

Acid and Chemical-Resistant Cements

The selection of the correct type of brick is relatively easy. However, the choice of cement is equally important for, like the proverbial chain, the lining is only as effective as its cement. The application of the cement requires artisanship.

(1) Cements for acids (except HF) are as follows: Sodium silicate cements are made up of Na_2—3.86 SiO_2 with suitable fillers such as china



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clay, asbestos, barytes, silex or sand, plus either an organic acid like oxalic or stearic or a hydroxide addition. This results in a chemical setting cement which requires but 24 hours to set; otherwise, approximately 30 days may be needed to obtain a permanent set. The chemical setting cements must be worked within 20 minutes after the chemical is added. Cements containing no chemical setting ingredients may be applied more leisurely, and then chemical setting is obtained by washing the cement with a 5 per cent HCl solution.

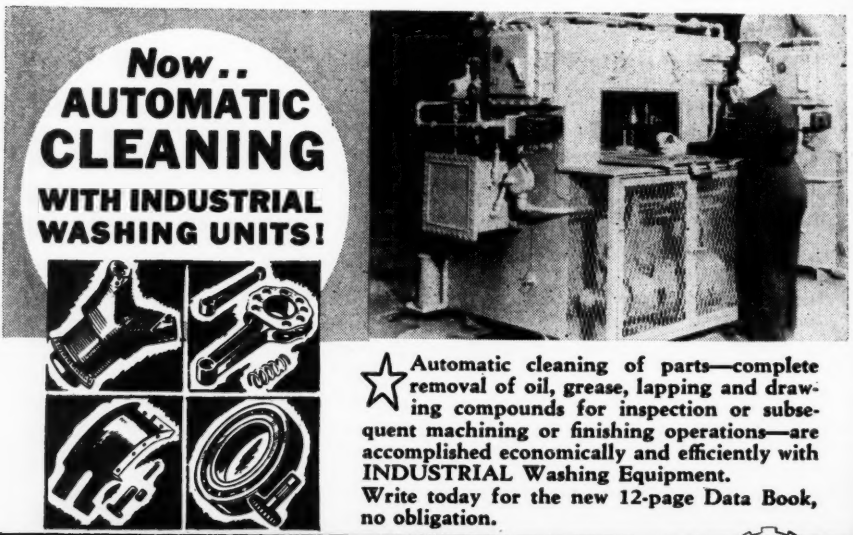
One typical formula for a chemical setting sodium silicate cement is: 20 parts of pulverized silica, 12 parts of English ball clay, 4 parts of powdered hydrated sodium silicate, 9 parts of water, and sufficient acid or hydroxide to provide quick setting.

Other acid-resisting cements are the following: (a) putty, made of equal parts of china clay, boiled linseed oil, melted with pitch—unsuitable for HNO_3; (b) cements made of natural rubber or of rubber-like material; (c) phenolic resinoid and other synthetic resin cements; (d) sulfur cements—e.g., sulfur, sand and Portland cement, or equal parts of sand and melted sulfur, or approximately equal parts of melted pitch and sulfur; (e) litharge and glycerine—except for sulfuric and acetic acids; (f) red lead and glycerine. The surfur cements withstand acids and alkalies up to 200 degrees F., but are rather difficult to apply inasmuch as they must be used hot.

Cements for use with the following chemicals and corrosive conditions are as tabulated:

(2) For ammonia use litharge and glycerine, or sodium silicate chemical setting cements.

(3) For hydrocarbons use (a) red or white lead in linseed oil, (b) Portland cement, (c) litharge and glycer-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ine, (d) molasses and flour, (e) silicate cements.

(4) For steam use (a) red or white lead in linseed oil, (b) litharge and glycerine, (c) graphite-in-oil, for pipe joints.

(5) For alkalies use (a) asphalt, (b) pitch, (c) sulfur cements, (d) iron cements. Iron cement may be, for example, 40 parts of oil-free iron filings, 10 parts of manganese dioxide, 1 part of sal ammoniac, 20-40 parts of Portland cement and water to form a paste.

Due to the difficulty of obtaining rubber cements at the present time, a substitute cement for joining hard rubber to steel is made by boiling down Cologne glue (cabinet maker's glue) and adding wood ash; for joining soft rubber to steel, the same mixture may be used and a little potassium chloride added to prevent complete drying of the glue, which will preserve the required flexibility.

One cement which is used for applying rubber to wood is made up as follows: 1 ounce gum shellac, 9.5 ounces strong ammonia, 100 ounces Indian rubber, 15 ounces rosin, 10 ounces shellac. All of the ingredients are dissolved in carbon disulfide.

All cement used between bricks or between brick and tank material should not be applied in thicknesses in excess of ⅛ inch. The heavier the consistency of the cement when applied, the less the contraction in setting. Contraction causes cracking and porosity.

Plating Rack Insulation

Numerous rack insulation compounds are offered for each plating sequence. Chromium plating rack insulation requirements are met by a few proprietary compounds and tapes. Anodizing rack insulation is one of the most difficult corrosion problems in the plating room. Rack insulation compounds offered for anodizing racks have provided insulation remarkably well, considering the obstacles to a really operative protection.

Protective Paints

The basic pigment "red lead" is the most widely used anti-corrosion paint. Sublimed blue lead, zinc chromate, and basic lead chromate are other popular rust inhibitors. Metallic paints using aluminum, copper, bronze and zinc are suitable for some exposures. Caustic alkalies, salt water and other corrosives soften pigment and metallic paints by attacking the vehicle. Therefore, for certain applications, the best protective films are asphalt or bitumen bases dissolved in suitable thinners. Gilsonite, elaterite and wurzilite are bitumens which form tough, leathery, flexible films.

Crêpe rubber paint, when available, gives a satisfactory acid and alkali resisting finish on metal, wood or concrete. It is quite impervious to fluids. Resin-impregnated plywood, which is resistant to most dilute acids, is available for surfacing work tables, tanks and walls.

Corrosion Vapor Control at the Source

The most prevailing corrosive vapors in plating rooms are apt to be around the chromium plating and chromic anodizing tanks. One method of reducing chromic acid spray is to blanket the surface of the bath with an inert material. Some inert materials may also be operative in reducing the corrosion and health hazards from acid pickling baths. The spray from caustic cleaning baths may be reduced by the use of anti-foaming agents, although the latter should not be used in alkaline baths for cleaning aluminum as they tend to passivate the surface of this metal. Anti-foaming agents also decrease the wetting power; therefore, effective cleaning may be lost.

The venting of plating and pickling

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THE ability of Alundum Abrasive to stay on wheel head until its job is done—even when conditions are severe—is a result of the special Norton treatments during manufacture, treatments that raise the grain's capillarity, that enable the glue or cement to function with maximum effectiveness. And other Norton treatments govern the shape of the grain thus assuring a wheel head that's fast cutting as well as long lived.

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NORTON ABRASIVES

operations is generally accomplished by edge venting and exhausting to the atmosphere. The present venting systems have proved acceptable; however, there is room for improvement.

"Electronic Precipitrons" is a generic term for a type of device promised after the war, as a means of clearing homes and factories of dust and fumes. An adaptation of such a device may also serve as an adjunct to the present venting systems.

Physical Requirements of Corrosion-Resistant Materials

Corrosion resistance is not the only factor which must be considered in selecting material for tanks and plating room equipment. For many operations, low heat transfer is desirable and low liquid absorption is important in electroplating tank linings. The replacement of one material by another equally corrosion-resistant material, in one instance, realized a saving of 38 per cent of the electric cosumption, as the replaced material had high liquid absorption properties. Other mechanical considerations may be (1) resistance to thermal shock, (2) structural strength, (3) coefficient of thermal expansion, (4) impact strength and (5) dielectric strength. Excessive weight of a lining may be a limiting factor where floor loading must be taken into consideration.

TABLE II.

This table does not present the results of a conclusive investigation; the listed choices were indicated in a limited survey.

Pickling-Cleaning-Plating Solutions and Operations	Materials for Tanks—Lining	
	Usual Choices	Alternate Choices
Water, Dyes, Acid Salt Solutions	Steel	Wood, "Monel"
Acid Pickling, Electrolytic-Pickling	Lead	Chemical-Brick, Glass, Rubbers, "Monel" Carbon, Ceramics, Ashaplt
Ferric Sulphate Pickling	Lead, Glass Chemical-Brick	Ceramics, Asphalt
Stainless and Chrome Steels Pickling	Lead	Ceramics, Asphalt
Cold Nitric Solution	Lead, Asphalt, Aluminum, 18-8 Stainless	Chemical-Brick, Glass, Ceramics, Rubbers
Hot Nitric Solution	Chrome—Iron, Lead, Aluminum, 18-8 Stainless	Chemical-Brick, Glass, Ceramics, Rubbers
Fire-Off-Pickling	Lead, Chrome—Iron	Chemical Brick
Hydrofluoric Acid, and Mixtures, Fluoride Electrolytes	Lead, Carbon, Asphalt	Wax, Rubbers, Phenolic-Resinoids
Alkaline and Electrolytic Cleaners	Steel	Copper, "Monel,"—Asphalt
"Petroleum" Solvent Degreasers	Steel	
"Chlorinated" Solvent Degreasers	"Monel"	Steel
Electrolytic-Polishing of Metals	Asphalt, Ceramics	Chemical-Brick, Rubbers, Steel, Copper

(Continued on page 80)

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This picture shows two typical parts that are well within the wide work range of mechanical finishing by Roto-Finish. These large castings with their compound surfaces and recessed areas were quickly deburred and finished by this revolutionary new process. It works equally well on steel, brass, aluminum, stainless and nickel steel.

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Bonderizing and Phosphate Solutions	Steel	Chemical-Brick, Ceramics, Glass
Alkaline Electrolytes (Cu-Zn-Cd-Sn-In-Ag. and so on)	Steel	Chemical-Brick, Ceramics, Glass
Acid Electrolytes (Cu-Ni-Cr. and so on)	Lead	Chemical-Brick, Rubber Glass, Ceramics, Plastics
Black Nickel Electrolyte	Carbon, Rubber	
Iron Black-Oxide-Solutions	Steel	Same as phosphates or caustic solutions
D.C. Aluminum Anodizing H_2SO_4	Lead	Rubber
A.C. Aluminum Anodizing H_2SO_4 and Modifying Salt	Glass, Chemical-Brick	Carbon
A.C. or D.C. Chromic Acid Anodize—and K or Na dichromate solutions	Steel	Lead, Glass, Chemical-Brick
Magnesium Anodizing	Steel	
Aluminum Plating Passivators	Steel	Ceramics,—18-8 Stainless Steel
HCl and Iron Chloride Electrolyte	Chemical-Brick, Hard Rubber, Antimonial-Lead	Hastelloy "A," Glass, Ceramics, (Copper Si-Mn alloy), Pastics

TANKS: Tanks are generally set on piers in order to permit of better drainage and to prevent bottom corrosion.

FLOORS: ⅛-inch pitch toward drains. Asphalt or pitched concrete, with chemical-brick, laid edgewise if heavy traffic exists.

PUMP LININGS, PIPING, and so on, for acid solutions (except HF) Silicon-Iron, Lead, Monel, Ceramics, Rubber, Glass, Plastics, (For HF—Carbon, Lead, Rubber).

COVERS: Chromium plating and Chromic Acid Anodizing tanks require drop or hinged covers for use when operating. Solvent degreasers require fused covers for safety.

BASKETS: For pickling and cleaning operations: Monel, Stainless Steels, Nichrome, Ceramics, Plastics, Rubber, Brass, Bronze, Steel.

ANODIZING RACKS: Aluminum 17S—24S—61S for both Aluminum and Magnesium anodizing processes.

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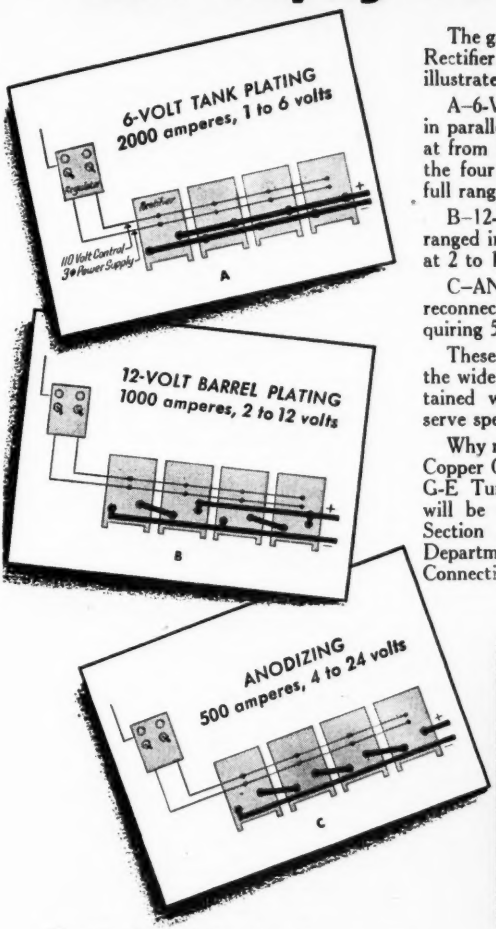


The great flexibility of the G-E Copper Oxide Rectifier in meeting varying D-C needs is plainly illustrated in the diagrams at the left.

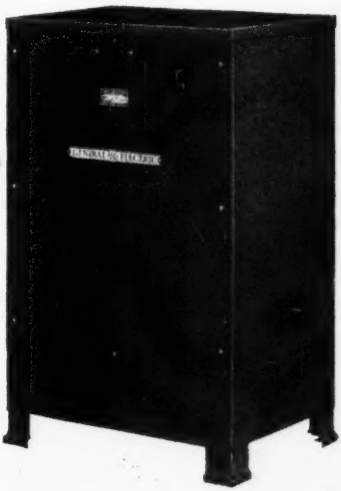
A–6-VOLT TANK PLATING: Connected in parallel, the four rectifiers give 2000 amperes at from 1 to 6 volts. The single regulator for the four units gives complete control over the full range output.

B–12-VOLT BARREL PLATING: Re-arranged in series-parallel, they give 1000 amperes at 2 to 12 volts.

C–ANODIZING: The same four rectifiers reconnected in series for an anodizing job requiring 500 amperes at 4 to 24 volts.

These are only three common examples of the wide variety of groupings that can be obtained with G-E Copper Oxide Rectifiers to serve specific needs, including 40 volt anodizing.

Why not investigate the potential uses of G-E Copper Oxide Rectifiers in your electroplating? G-E Tungar and Metallic Rectifier engineers will be glad to consult with you. Write to Section A644-70, Appliance and Merchandise Department, General Electric Co., Bridgeport, Connecticut



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GENERAL ELECTRIC

The Chemistry of Electroplating

By Dr. C. B. F. Young, Consultant

Part 9

IN the last article the compounds of nitrogen were studied and the properties of many of these materials and methods of producing were given. In the present chapter ionic reactions are illustrated in detail and then sodium and potassium compounds are studied.

As has been discussed before, compounds are roughly divided into two different types: polar, those which ionize and conduct electric current, and non-polar compounds, those which do not ionize and, therefore, do not conduct an electric current. Examples of polar compounds are sodium chloride, nickel sulfate, and sulfuric acid, while good examples of non-polar compounds are carbon tetrachloride, trichlorethylene, and sugar.

It must be said at this point that there is not a sharp distinction between the two classes; for instance, weak bases and weak acids fall between the two classes. Also, concentrated sulfuric acid is not ionized. Many other discrepancies could be mentioned, but this is enough to show the student the main difference between the two types.

Acids and bases are polar compounds and have been discussed before, but at that time the subject of ionization had not been taken up and discussed fully. Upon examination it will be found that all acids contain hydrogen. On the other hand, it might be noted that all compounds that contain hydrogen are not necessarily acids. The reason for this will be simple when pointed out.

If a material contains hydrogen and this ionizes to produce hydrogen ions (H^+), the compound is an acid, but if no hydrogen ion is produced the material is not an acid. It is the same old story of saying that every horse is an animal, but every animal is not a horse. Therefore, an acid can be defined as a compound which, dissolved in water, produces hydrogen ions.

The properties of acids are all due to one thing: that is, the hydrogen ion. This material gives rise to the sour taste neutralization of bases, and the reddening of litmus paper. Acids can be divided into different groups depending upon how many hydrogens are present. Thus, monobasic acids give rise to one hydrogen ion. Examples are HCl and HNO_3. Dibasic acids yield two hydrogen ions per molecule. An example is H_2SO_4. Tribasic acids will yield three hydrogen ions — for instance, H_3PO_4.

A base may be defined as any material which produces hydroxyl ions in a water solution. It can also be

said that the peculiar properties exhibited by bases are due to the hydroxyl ion. Bases can be divided into classes also. A monoacid base yields one hydroxyl ion per molecule. KOH and NaOH are examples. Magnesium hydroxide ($Mg(OH)_2$) is a diacid base and $Al(OH)_3$ (aluminum hydroixde) is a triacid base. Salts can be defined as the products of neutralization of an acid by a base.

If the water solutions of many acids and bases are investigated, it will be found that they are rather poor conductors of electric currents. What can be the reason for this? It will also be noted that these materials are not as active as materials which conduct a current very readily. A good example of one of these materials is acetic acid. This will not attack materials as readily as will hydrochloric acid.

Dr. C. B. F. Young

The answer simply is that the acetic acid does not produce as many hydrogen ions as does hydrochloric acid. These materials are called weak acids or bases. Another good example of a weak acid is sulfurous acid. This material, when dissolved in water, does form some hydrogen ions according to the equation below:

$$H_2SO_3 \rightleftharpoons 2H^+ + SO_3$$

Now, sulfurous acid does not give rise to many hydrogen ions. On the other hand, it is known that this compound is soluble in water because it dissolves very easily. What becomes of that part which does not give hydrogen ions? The hydrogen ion simply unites with the sulfite ions to produce molecular H_2SO_3, which does not give rise to a test for an acid. Therefore, it can be said that most of the sulfurous acid is a weak acid because it produces few hydrogen ions. From the standpoint of a base, ammonium hydroxide is weak because it produces, when dissolved in water, comparatively few hydroxyl ions. This may be represented as shown below:

$$NH_4OH \rightleftharpoons NH^+_4 + OH^-$$

To show that it is a weak acid the arrow pointing to NH_4OH is heavy while the arrow pointing to the disassociating products is light. Thus, one sees that most of the aluminum hydroxide is in the molecular state.

When an acid and a base come together, neutralization occurs. It can also be said that this reaction goes to completion. True, it does not go to complete neutralization, but for a practical proposition it may be considered so. The essential reaction of neutralization is the combination of a hydrogen ion of the acid with a hydroxyl ion of the base, forming water. One has a right to ask about the driving force behind this reaction. The driving force is simply the fact that the water which is formed is removed from the zone of action and does not disassociate to form hydrogen ions or hydroxide ions again. Perhaps an example will make this clear. When HCl is neutralized by NaOH the following reaction takes place:

$$\begin{array}{l} HCl \rightleftharpoons H^+ + Cl^- \\ NaOH \rightleftharpoons OH^- + Na^+ \\ \qquad\quad \downarrow\uparrow \qquad\quad \downarrow\uparrow \\ \qquad\quad H_2O \qquad NaCl \end{array}$$

From the above it can be seen that hydrochloric acid disassociates into

hydrogen ions and chlorine ions. The reverse, however, is also true. Again sodium hydroxide disassociates into sodium ions and hydroxide ions. The sodium ion unites with the chloride ion to form NaCl and these reactions are also reversible, but when the hydrogen ion unites with the hydroxide ion to form water no reverse action is present. Therefore, the reaction must go to the right. This can also be written:

$$H^+ + Cl^- + Na^+ + OH \rightleftharpoons Na^+ + Cl^- + H_2O$$

In every case it will be noted that the solution as a whole is electrically neutral as the number of positive ions equals the number of negative ions.

Nearly all reactions occurring in water are ionic reactions. These are instantaneous and at once reach the end point. Just what the end point will be depends upon the ionic equilibria. This is determined by the properties of the materials under consideration. For instance, if potassium chloride and sodium sulfate are mixed, the reaction does not necessarily form potassium sulfate and sodium chloride because there is no driving action between these compounds. However, there are potassium ions, sulfate ions, sodium ions and chloride ions. On the other hand, if potassium chloride is added to silver nitrate the reaction will go to completion because silver chloride will form and, being insoluble, will precipitate from the solution, leaving behind potassium nitrate. These two reactions can be represented as follows:

1. $K^+ + Cl^- + 2Na^+ + SO{=}_4 \rightleftharpoons K^+ + Cl^- + 2Na^+ + SO{=}_4$
2. $K^+ + Cl^- + Ag^+ + NO^-_3 \rightleftharpoons K^+ + NO^-_3 + AgCl\downarrow$

The last reaction goes to completion for the simple reason that the silver ion and the chloride ion unite to form molecular silver chloride, and are removed from the zone of action.

Every ionic reaction is reversible to a certain extent but the reversibility, in some cases, is so slight that it is disregarded and assumed to be complete. Thus, for the formation, silver chloride, we can write:

$$Ag^+ + Cl^- \rightleftharpoons AgCl$$

It is true that silver chloride is very slightly soluble in water and, therefore, there is an equilibrium between the ions and molecular silver chloride, but it is very slight. The amount of silver chloride forming silver and chloride ions can be further decreased by adding either silver or chloride ions. From this it can be seen that ionic reactions can be made to go to completion under certain conditions. Ionic reactions go to completion if two oppositely charged ions produce insoluble materials or components which are slightly ionized, omitting, of course, oxidation and reduction equations. Types of reactions which go to completion can be enumerated as follows:

1. If a gas is formed which is insoluble in the solution, the reactions go to completion. For example,

$$2HCl + Na_2CO_3 = 2NaCl + H_2O + CO_3$$

2. If insoluble precipitates occur when two ions of opposite charge unite, the reaction goes to completion. For instance:

$$BaCl_2 + Na_2SO_4 = BaSO_4\downarrow + 2NaCl$$

$BaSO_4$ is insoluble in water.

3. When two oppositely charged ions unite to form a material which is slightly ionized the reaction will go to completion. The best example of this is the neutralization of an acid with a base, producing water.

Every student desires to know what compounds are soluble and insoluble in water and in order to make this matter easy some general rules of

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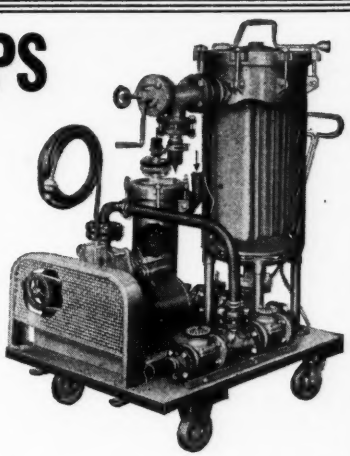

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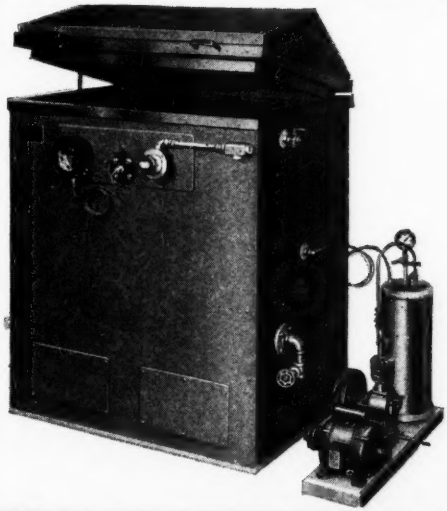

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solubility have been written below. One will do well to learn these six groups:

1. All nitrates, acetates, and chlorates are soluble in water.

2. All sodium, potassium, and ammonium compounds are soluble in water.

3. All sulphates are soluble in water except barium sulphate, lead sulphate, and calcium sulphate.

4. All chlorides are soluble in water except those of silver, mercury, and lead.

5. All oxides and hydroxides are insoluble in water except ammonium hydroxide, sodium hydroxide, potassium hydroxide, and barium hydroxide. Calcium hydroxide is slightly soluble.

6. All carbonates are insoluble in water except those of sodium potassium and ammonium.

In a previous study it was shown that valence was the ability of one element to combine with another element. It was also stated that valence had a certain number of hooks or hands with which it could join with another element.

Let us now reconsider these definitions, bringing in the electric charge. It is known, for instance, that some elements have a positive while others have a negative valence; also, for two elements to unite, one must be positive while the other is negative. Instead of putting hands, hooks, or arms on the elements, the valence can be designated by using the proper number and type of charges. Thus, hydrogen has a valence of one and is positive. This can be written H^{+}. Sodium, in like manner, Na^{+}. Nickel has two positive charges and can be written Ni^{++}. Aluminum has three positive charges and can be described as Al^{+++}.

On the other hand, the non-metals are negative. For instance, chlorine has one negative charge, which can be expressed Cl^{-}. Likewise, OH^{-} and NO^{-}_{3}. The student at first might think that sodium, for instance, gained a positive charge in going from sodium metal to sodium ion, and that chlorine in going from gaseous state to the chloride gained one negative charge. The last part is true. Chlorine does gain one electron as shown below:

$$Cl_2 + 2\ (\theta) = 2Cl^{-}$$

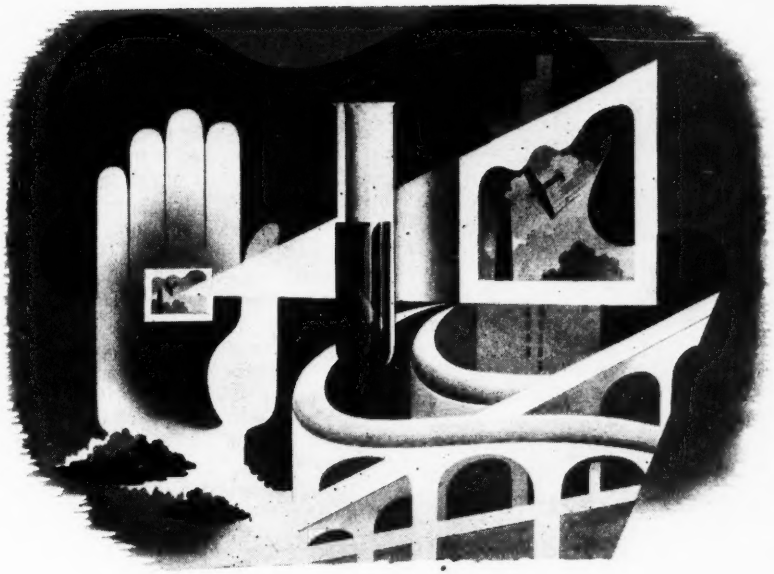
However, sodium does not gain a positive charge or proton. The reverse is true. Sodium loses an electron or negative charge and there remains one positive charge on the sodium.

$$Na^{\circ} - (\theta) = Na^{+}$$

A proton or positive charge is very much heavier than an electron; in fact, it is about 1845 times as heavy. In comparison to the electron it is massive and bulky and hard to move around, whereas the electron is light and can move with great rapidity. In every reaction known it is always the electron, and not the proton, that is lost or gained. If the metal sodium unites with chlorine to produce sodium chloride, the sodium loses one electron to the chlorine so that the sodium becomes Na^{+} and the chlorine becomes Cl^{-}.

There are a number of ions which will combine with other ions or molecular materials to form complex ions. In some cases it is possible to obtain complex solid salts from these solutions. Thus, it is possible to dissolve silver chloride with ammonium hydroxide, producing soluble silver ammonium chloride. In the electroplating industry much use is made of the formation of complex ions because it is generally known that better deposits result when complex ions are present. The cyanides are used to form these complex materials. For zinc a complex is formed as shown:

$$Zn(Cn)_2 + 2NaCn \rightleftharpoons Na_2Zn(Cn)_4$$



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This material ionizes as follows:

$$Na_2Zn(Cn)_4 \rightleftharpoons 2Na^+ + Zn(Cn)=_4$$

It will be noted from the above that no zinc ion is present, and in this condition zinc could not be deposited if a current were passed through such a solution. However, the latter complex ion ionizes slightly to produce two ions as follows:

$$Zn(Cn)=_4 \rightleftharpoons Zn^{++} + 4Cn^-$$

Copper cyanide also unites with sodium cyanide forming a compound which has the formula $Na_2Cu(Cn)_3$. This ionizes the same as does the zinc.

$$Na_2Cu(CN)_3 \rightleftharpoons 2Na^+ + Cu(CN)=$$
$$Cu(CN)=_3 \rightleftharpoons Cu^+ + 3CN^-$$

Silver acts in much the same way.

$$AgCN + KCN \rightleftharpoons KAg(CN)_2$$

This can also be formed with other silver compounds.

$$AgCl + 2KCN \rightleftharpoons KAg(CN)_2 + KCl.$$

$KAg(CN)_2$ ionizes as follows:

$$KAg(CN)_2 \rightleftharpoons K^+ + Ag(CN)^-_2$$
$$Ag(CN)^-_2 \rightleftharpoons Ag^+ + 2CN^-$$

Sodium chloride is a very important salt of sodium and is mined as NaCl. This has been discussed before and the student is referred to previous lessons to review on this important material.

Sodium carbonate is now made by the "Solvay" process. It originally was made by the LeBlanc method, but the former is cheaper and has now supplanted this process. The LeBlanc process will not be discussed as it is obsolete, but the Solvay process will be taken up. A saturated solution of sodium chloride is saturated with ammonia and carbon dioxide to

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In planning your quota campaign, work in close cooperation with the Chairman of your War Finance Committee. Everything is set to make the 5th War Loan drive a huge success—with your help!

Here's the Quota Plan:

1. Plant quotas are to be established on the basis of an *average* $100 *cash* (not maturity value) purchase per employee.
2. Regular Payroll Savings deductions made during the drive accounting period will be credited toward the plant quota.
3. 90% of the employees are expected to contribute toward raising the cash quota by buying extra 5th War Loan Bonds: 1—Outright by cash. 2—By extra installment deductions. 3—By extra installment deductions plus cash.

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form, at first, ammonium bicarbonate which, in turn, reacts with sodium chloride to form sodium bicarbonate. This salt, being only partially soluble in the solution, precipitates and this is heated to form the sodium carbonates. The reaction is as follows:

$$NH_4OH + H_2CO_3 = (NH_4)HCO_3 + H_2O$$
$$(NH_4)HCO_3 + NaCl = NaHCO_3 + NH_4Cl$$
$$2NaHCO_3 = Na_2CO_3 + H_2O + CO_3$$

The reaction is carried out in large water towers in which are numerous shelves and water traps so that complete mixing is assured. The temperature of the reaction should not go above 35 degrees C. The ammonium chloride which is produced in the reaction as shown by the second equation is expensive and cannot be wasted. This material is heated with lime so that ammonia is released. The lime is obtained by heating calcium carbonate. The chemical reactions are given here:

$$CaCO_3 = CaO + CO_2$$
$$CaO + H_2O = Ca(OH)_2$$
$$Ca(OH)_2 + 2NH_4Cl = CaCl_2 + 2NH_3 + 2H_2O$$

The carbon dioxide which is released in the first reaction is used in the carbonating tower. The calcium hydroxide produced is used for regenerating the ammonia. The end products are sodium carbonate and calcium chloride. Calcium chloride is of very little commercial value. The raw materials are calcium carbonate, which is limestone, and sodium chloride. Both materials can be obtained very cheaply.

In the paragraph above one learned how to manufacture sodium carbonate from sodium chloride. If the reaction is stopped short and the last step is not allowed to take place, the product is sodium, hydrogen carbonate or sodium bicarbonate. Sodium bicarbonate solutions are neutral. Sodium bicarbonate can be produced from sodium carbonate by saturating a water solution of sodium bicarbonate with carbon dioxide, sodium bicarbonate being precipitated:

$$Na_2CO_3 + H_2O + CO_2 = 2NaHCO_3$$

The reverse reaction will take place if the sodium bicarbonate is heated. Either sodium bicarbonate or sodium carbonate will react with an acid producing salt, and carbon dioxide according to the equation below:

$$NaHCO_3 + HCl = NaCl + H_2O + CO_2$$
$$Na_2CO_3 + 2HCl = 2NaCl + H_2O + CO_2$$

Sodium carbonate can be obtained as a dry powder or in the crystalline form, which is nothing more than sodium carbonate hydrated. The first material has the formula Na_2CO_3, while the second has the formula of $Na_2CO_3 \cdot 10\,H_2O$.

Sodium sulfate, Na_2SO_4, is found in nature as such, but also has a hydrate, $Na_2SO_4 \cdot 10\,H_2O$, which is known as Glauber's salts. Large amounts of this material are used in glass making and in the manufacture of certain types of paper. This salt can be obtained by the reaction of sodium nitrate with sulfuric acid.

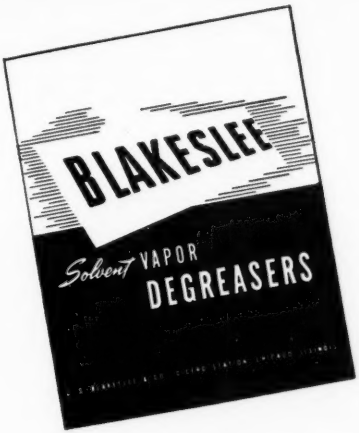
$$2NaNO_3 + H_2SO_4 = 2HNO_3 + Na_2SO_4$$

Sodium sulphite is obtained by adding sulfur dioxide to a saturated solution of sodium carbonate and then adding a definite amount of carbonate. The reactions are as follows:

$$Na_2CO_3 + 2H_2SO_4 = H_2CO_3 + 2NaHSO_3$$
$$Na_2CO_3 + 2NaHSO_3 = H_2CO_3 + 2Na_2SO_3$$

One of the best ways of preparing sodium cyanide is to fuse cyanamide with carbon and sodium carbonate.

$$CaCN_2 + NaCO_3 + C = CaCO_3 + 2NaCN$$



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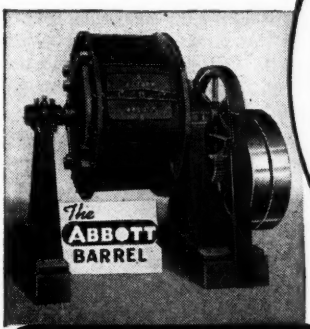

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The sodium cyanide produced can be dissolved away from the other material by using water as a solvent.

Sodium thiosulfate is also known to photographers as hypo and is used to dissolve the unused silver bromide from the developed plates. It can be formed very easily by boiling sodium sulfite with sulfur.

$$Na_2SO_3 + S = Na_2S_2O_3$$

Sodium sulfide is a very soluble sodium salt and can be produced by reducing sodium sulfate with carbon at 900 degrees C.

$$Na_2SO_4 + 2C = Na_2S + 2CO_2$$

Sodium nitrate is obtained from the great saltpeter beds which are in Chile. This is a very important source of nitrogen. It can also be made synthetically.

Sodium nitrite can be obtained from sodium nitrate by heating the former salt as follows:

$$2NaNo_3 = 2NaNO_2 + O_2$$

There are three sodium phosphates: the monosodium, disodium, and the trisodium. Their formulas are NaH_2PO_4, Na_2HPO_4, and Na_3PO_4, respectively. Each of these is prepared by adding the correct amount of sodium hydroxide to phosphoric acid.

If sodium carbonate is dissolved in water and the resulting solution tested with red litmus, much to the surprise of the student the red litmus will turn blue, indicating a basic reaction. Why is this? How do we account for it?

The simple explanation is that water reacts chemically with certain types of salts to produce acids or bases, as the case may be. Water is very slightly ionized to produce hydrogen and hydroxyl ions. This slight ionization plays an important part with certain salts as we will now see.

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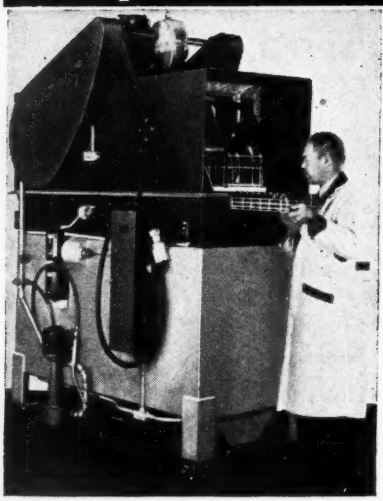

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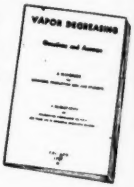

Contains specific information on degreasing problems, solvents, solvent toxicity and control, solvent recovery, and many practical applications.

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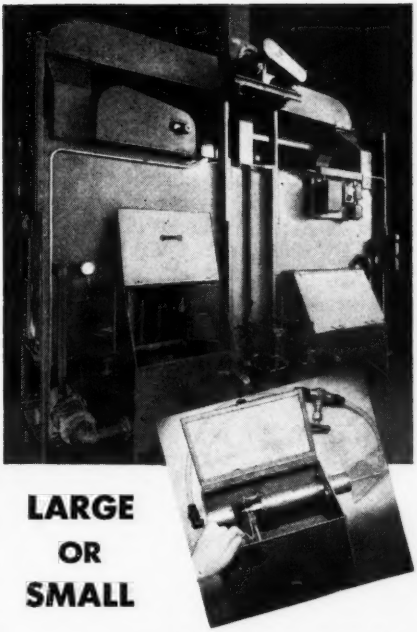

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NO part is too large, too small, or too intricate to be cleaned by one of the many types and sizes of American metal wash machines.

Moreover, these machines incorporate many new and exclusive design features and vastly improved washing methods that are enabling users to do a higher quality cleaning job, in far less time, and at lower cost.

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If sodium carbonate is analyzed it will be found to consist of a strong base (sodium hydroxide) and a weak acid (carbonic acid). If this sodium ion can find a hydroxyl ion with which to unite, sodium hydroxide will be produced.

At the same time if the carbonate ion can find a hydrogen ion with which to unite, carbonic acid will be produced. Sodium hydroxide is a much stronger base (that is, ionizes more) than carbonic acid is an acid. Thus, one would expect a basic reaction to occur if sodium hydroxide and carbonic acid were formed in solution. This can be written as below:

$$2H_2O \rightleftharpoons 2H^+ + 2OH^-$$
$$Na_2CO_3 \rightleftharpoons CO_3^= + 2Na^+$$
$$\downarrow\uparrow \qquad \downarrow\uparrow$$
$$H_2CO_3 \qquad 2NaOH$$

From the above equations it will be noticed that hydrogen and hydroxyl ions are formed, the hydrogen ions immediately combining with the carbonate ions to form molecular H_2CO_3, while the hydroxyl ions do not combine with the sodium ions to form the molecular material, but form ionized sodium and hydroxyl ions. Thus, it can be seen that sodium carbonate reacts slightly basic whenever the ions of water react with a salt. The reaction is called hydrolysis. It takes place when a salt of a strong base and a weak acid or a strong acid and a weak base are dissolved in water. In the first place an alkaline reaction occurs, and in the second place an acid reaction is produced.

Potassium and sodium compounds are very similar in their reactions. As a general rule it might be stated that potassium salts are more soluble and are more expensive than sodium salts. In nearly every case the chemical reactions are the same.

Metallic sodium and potassium are obtained by electrolyzing the fused sodium or potassium hydroxide. Due to research which has been carried on in the last few years, these metals can also be obtained by electrolyzing the corresponding chloride salt instead of the hydroxide.

The electrolysis of a fused salt is similar to an aqueous solution except that no water is present. The salt is heated until liquid and then a current is passed through, as these materials in the molten state will conduct an electric current. The sodium or potassium is produced at the cathode while oxygen or chlorine is produced at the anode. Both of these metals are very soft and have a silver white lustre. They are very active and will oxidize in the atmosphere at once. In order to protect the metals from oxidation they must be placed under an unreactive solution such as kerosene. This prevents the oxygen of the atmosphere from combining with the metals.

If sodium is heated in the air, sodium peroxide (Na_2O_2) is formed. This material contains one more atom of oxygen than sodium oxide and for that reason is a strong oxidizing agent.

As nearly all salts of sodium and potassium are soluble, other methods besides insoluble precipitates for testing of these materials must be used. Bunsen developed a flame test for these materials. Sodium or potassium salts give a characteristic color when placed in the flame. Sodium compounds produce a yellow flame, while potassium compounds produce a purple or violet flame.

(Part 10 will be published in our July issue.)

Spencer Binocular Microscope. Inspection and control of surface finish with the use of the Spencer Binocular Microscope are outlined in a folder distributed by George Scherr Co., Inc., 200 Lafayette St., New York 12, N. Y. Several models are illustrated. Copy free upon request.

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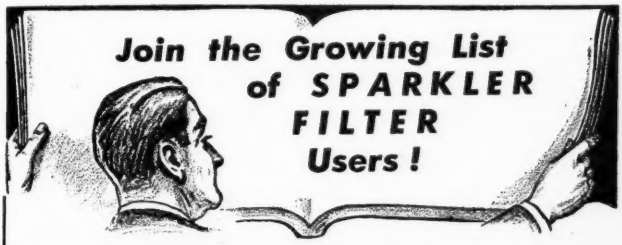

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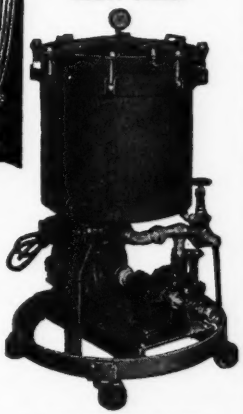

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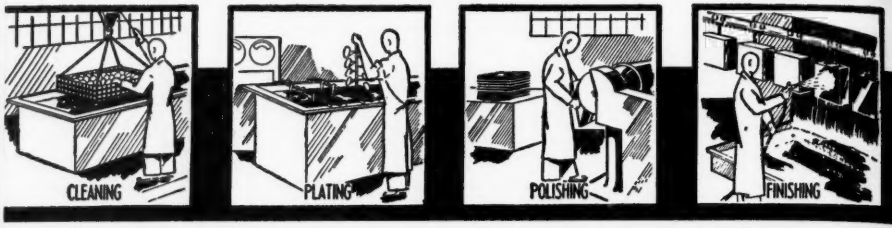

News of the Industry

Pflug Promoted by Detrex Corporation

W. F. Newbery, industrial sales manager of Detrex Corporation, Detroit 27, Mich., announces the appointment of R. W. Pflug as manager of the company's central region territory, which com-

R. W. Pflug

prises the states of Michigan, Ohio, Indiana, Kentucky and West Virginia.

Mr. Pflug was previously manager of sales and service in the north central region. New larger branch headquarters have now been established in Detroit, as well as in other principal cities, which will facilitate the handling of orders and service.

P. W. Moehle, as divisional manager, will coordinate service and sales in the southern section of the central region covered by the Dayton branch office.

New Cowles Technical Engineer for Chicago

The Cowles Detergent Company, Cleveland, Ohio, announces the appointment of Norman E. Garman as technical engineer for the Chicago territory. Mr. Garman is an experienced process metallurgist and is well equipped with education and experience to render expert service on all kinds of metal cleaning problems.

Oakite Third War Production Conferences

Concurrently held in New York, Chicago and Los Angeles were the Oakite Third War Production Conferences on cleaning, de-scaling, de-rusting, degreasing and related production and maintenance operations. Participating with the entire field technical service representatives were the staffs of the mechanical engineering, chemical and research laboratories and general headquarters of Oakite Products, Inc., 20 Thames St., New York 6, New York.

These two-day sessions were devoted to the collating of field experience in order to determine the best and most practical methods for stepping up wartime production through speedier cleaning, due consideration being given to the emergencies of manpower and the shortage of time. Also discussed were concrete, workable techniques for prolonging equipment life; improving plant sanitation and maintenance; faster, more thorough cleaning in repair and overhaul procedures.

The data exchanged by the technical

representatives revealed successful methods for improving adhesion of organic finishes to ferrous metals; prevention of rust between production operations; preparation of aluminum for spot welding, anodizing, Alroking, painting and other surface finishing operations; stripping identification paint from aluminum and aluminum alloys; preparation of basis metals for electroplating, and study of coolants and lubricants in machining operations.

Data and information resulting from the discussions held at the various meetings are freely available to all through the medium of the Oakite Technical Field Service.

Selas Corporation of America

Selas Corporation of America (formerly The Selas Company), Erie Ave. & D St., Philadelphia 34, Pa., announces official change of its corporate name, as above indicated. The action was necessitated by recent expansions and by ramifications of the company's domestic and export activities. No change in organization, service, personnel or objectives is implied.

Weber Named Glidden Advertising Manager

Appointment of Elmer L. Weber to the position of advertising and sales promotion manager of the Paint Division of the Glidden Company, Cleveland 2, Ohio, has been announced by Dwight P. Joyce, Glidden vice president.

Mr. Weber has had many years of successful experience with the Standard Envelope Manufacturing Company and the Edwards & Franklin Company, both in Cleveland. He is currently secretary of the Sales Executive Club of Cleveland.

In joining Glidden, Mr. Weber succeeds P. L. Lotz, who was relieved of the advertising post at his own request and will transfer to California for special sales work with the Glidden Pacific Coast Division.

Maas & Waldstein Expands

Maas & Waldstein Company, Newark, N. J., has practically doubled its present site by the purchase of an adjacent tract of land. The newly acquired land has a frontage of 245 feet on Riverside Ave., Newark. It is served by a spur of the Erie Railroad.

Pennsalt District Sales Manager

The Pennsylvania Salt Manufacturing Company, 1000 Widener Bldg., Philadelphia 7, Pa., announces the appointment of Gilbert H. Corbin, formerly field sales manager of its Laundry and Dry Cleaning Division, to be district sales manager in charge of the company's Minneapolis office. Mr. Corbin has been associated with the Laundry and Dry Cleaning Division since it was established in 1940, following the purchase of Sterling Products Company. He had been associated with the latter company for about 13 years.

The company believes that Mr. Corbin's transfer to the Heavy Chemical Division will place the Minneapolis office in charge of a man who will ably carry on the splendid work which Thomas M. Gillespie has done in the Wisconsin territory during the past 13 years. Mr. Gillespie has left the company to establish his own business as a manufacturers' agent serving the pulp and paper industry.

Bristol Branch Office

H. E. Beane, sales manager of The Bristol Company, Waterbury 91, Conn., announces the opening of a new Cleveland branch office. The office, located in the Engineer's Building, Cleveland 14, Ohio, will serve the states of Kentucky and Ohio with the exception of the Toledo area.

Mr. Beane also announces the appointment of G. H. Gaites as regional sales supervisor of the Cleveland and Pittsburgh territories. Mr. Gaites will make his headquarters at the Cleveland branch office.

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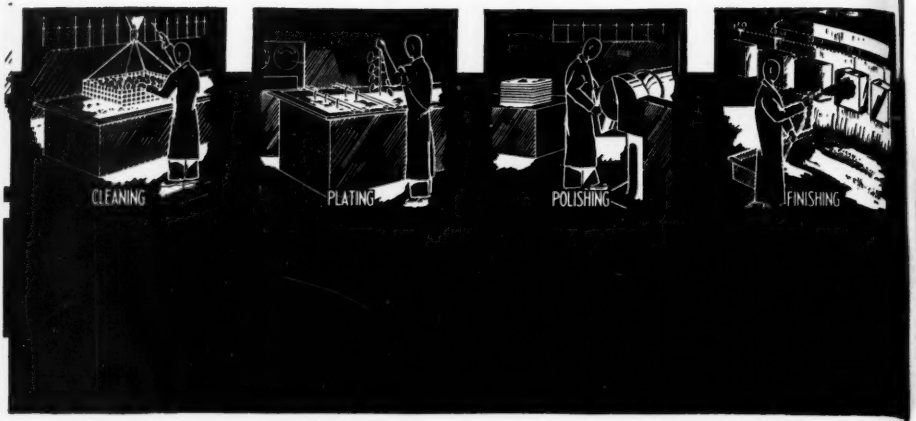
TURKISH — NAXOS — AMERICAN

KEYSTONE EMERY MILLS *Write for Sample* 4316 Paul St., Phila., Pa.



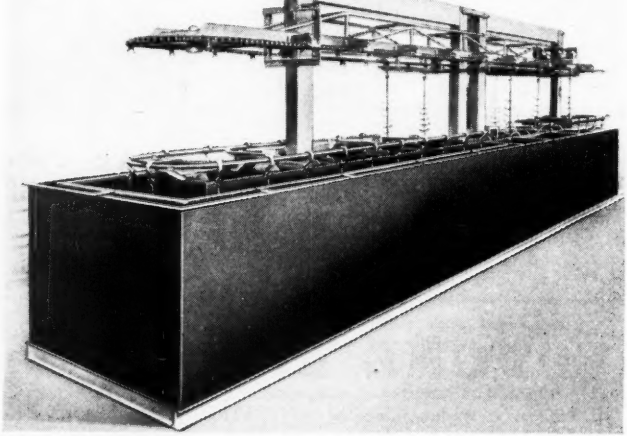
Udylite Fully Automatic Plating Machine

The Udylite Corporation, 1651 E. Grand Blvd., Detroit 11, Mich., has recently developed a "packaged" full automatic plater which can be sold as a complete unit, shipped in assembled condition in one freight car, and easily installed by the buyer's own men upon arrival. This development is the result of a survey conducted by Udylite, in which it was shown that a high proportion of all electroplated parts could be handled efficiently and economically on a full automatic plating machine. It is claimed that the most workable size for such a machine, to be used in the average plant, would be approximately 35 x 6 x 9 feet.

A square-type, space-saving transfer system was worked out which not only requires less space, but permits a wide variety of transfer speeds—lift, transfer and lowering rate being variable, independently. Racks are spaced on 18-in. centers, but this may be varied without readjustment of the transfer mechanism.

The operating principle is simple and the unit has few moving parts. A single row carrier system avoids crowding and burning on turns, and handles up to 76 racks per hour, variable to work requirements. Heavy duty copper anode and cathode rods afford positive self-aligning hook contact.

A single hydraulic mechanism provides smooth, positive transfer. The



Udylite Fully Automatic Plating Machine in Transfer Position

electric arc welded steel superstructure is carefully counterbalanced so that the transfer lifts only the weight of eight loaded racks at one time.

Compact size and easy movability make the unit a natural for use as part of the regular production line, saving hours of lost "handling" time in trucking parts to a central plating installation. The compactness of these full automatics also encourages their use in multiple units or batteries to meet exact job requirements. Quick convertibility to new jobs, individually, after the need of a battery no longer exists, is another feature. Shipping weight, 13,500 pounds.

Solvade

"Solvade" is the name which has been selected for a solvent extender, penetrant, cleaner and degreaser which has been placed on the market by Biofen Laboratories, 14 Sixth St., Bridgeport 7, Conn. Solvade is a yellow viscous liquid, which is completely soluble in all hydrocarbons, stoddard solvent, solvesso, gasoline, kerosene, dry cleaners' solvent, and so on. The flash point is 112 deg. F.

Suggested uses for Solvade are as a solvent extender, penetrant, cleaner and degreaser; degreasing and cleaning agent for platers; cleaning and degreasing of all finished metal parts; solvent for oils, waxes and fats; cleaning agent for machinery, tools, motors and so on.

For immersion cleaning and degreasing, one part of Solvade is diluted with four or more parts of kerosene, gasoline, solvesso, stoddard solvent, dry cleaners' solvent or other solvent. The parts to be cleaned are dipped into the Solvade-solvent solution for three to five minutes, and then drained. If the solution is warmed to 140 deg. F., cleaning and degreasing time is said to be reduced to one minute or less. Solvade-solvent solution may also be applied with brush or cloth to machinery, motors, and so on.

Nu-Lite Plastic Apron

A plastic work apron which offers a means of protecting war workers against dermatitis and other industrial hazards has been placed on the market by Nu-Lite Manufacturing Company, Verona, N. J. The apron, said to have all the desirable qualities of rubber but with only one-seventh of its weight, is made of a resin impregnated into a fabric base. Under tests, the Nu-Lite material has

Nu-Lite Plastic Apron

CLEAN, SMOOTH THREADS

Use Roberts Burring Compond for • Faster production • Complete contacting of all irregular contours due to flexibility of wheels • Smooth, clean work and good color • Preserves all essential dimensions.

Write for samples and suggestions.

ROBERTS ROUGE CO.
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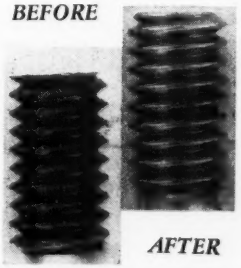

showed that it will shed water, oil, gasoline, acids and alkalis, and similar compounds.

It is claimed that extensive service tests on the aprons were run with results which showed complete protection and also freedom of movement due to the light weight of the material. A full-length apron for an average-sized operator weighs seven ounces. Sleeve protectors are made of the same material.

Jernstedt Electroplating Computer

An aid to the electroplater and plating chemist has been made available by the Hanson-Van Winkle-Munning Co. tawan, N. J. The instrument is called the Jernstedt Electroplating Computer. It is said to do for the plater what the slide rule accomplishes for the engineer —makes use of logarithmic scales to eliminate lengthy calculations.

It is claimed that the instrument accomplishes the following:

1. Computes chemical additions required in a plating bath of any gallonage, including cyanide additions.
2. Indicates weight of metal deposited on unit area, given the thickness. Metal costs can be quickly determined.
3. Lists usual cathode efficiencies of all modern electroplating solutions.
4. Gives plating time required to deposit a given thickness of any metal.

Jernstedt Electroplating Computer

5. Computes current density required to produce a deposit of given thickness.
6. Indicates thickness of deposit resulting from an established plating time at a known current density.
7. Space is provided for recording the standard composition of 20 different plating solutions. The normal temperature of operation and gallonage of each solution can also be recorded.
8. Lists component parts, in per cent by weight, of salts commonly used in electroplating.
9. Lists commonly used metric conversion equivalents.

Ault & Wiborg No. 988 Metal Impregnating Compound

For use in impregnating and sealing securely the tiny holes in magnesium, aluminum and other metal castings used in airplane engines, Ault & Wiborg, Division of Interchemical Corporation, Cincinnati, Ohio, has designed a synthetic resin specifically for use with monomeric styrene that overcomes the inadequacy of drying oils. The resin is a 100 per cent non-volatile compound, having a viscosity of Y-Z on the Gardner-Holdt scale (18-23 poises).

The usual mixing proportion is equal

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Best For Infra-Red Ray Drying
Nalco Dritherm Lamps are the carbon filament type...proved for years in therapeutic and industrial practice as providing maximum emanation of infra-red ray within the desirable penetration band. Made only by—
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Write for Interesting Details TODAY!
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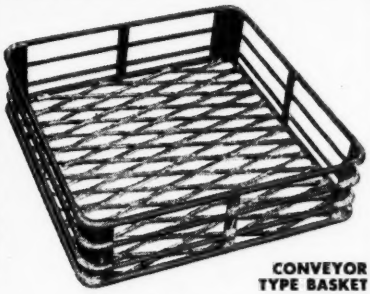
CARPENTER METAL BASKETS



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Write for illustrated folder describing our complete line of baskets.

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Write today for full data on how you can adopt the LUPOMATIC DEBURRMASTER equipment for deburring parts for the duration and for post-war plans, saving 85% of your finishing cost.

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● Today's substitute materials make Taber Abrasers absolute necessities. This accurate technique for testing wear resistance of surface finishes is made possible by scientific wearing action of "Calibrase" wheels. The results are recorded automatically in "wear cycles."

Standardize on Taber Abraser wear tests.

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TABER INSTRUMENT CORP.
111PF GOUNDRY STREET, NORTH TONAWANDA, N. Y.
Designers and Builders of Precision and Scientific Apparatus

parts resin and styrene, although this depends somewhat on the porosity of the casting. An equal parts mixture gives a viscosity of approximately 35 centipoises. If the casting capillary openings are small more styrene is used in the mixture—about 40 parts resin to 60 parts styrene. If they are large, the viscosity is increased by using a mixture of 60 parts resin to 40 parts styrene.

It is claimed that this resin has the property of cross-linking with the styrene molecule during polymerization without the aid of any catalyst. In fact, the impregnating solution is simply prepared by mixing the desired proportion of resin and stabilized monomeric styrene. Because of the cross-linkage between the two molecules, the co-polymer is gasoline insoluble.

The recommended impregnating procedure for sealing porous castings is the usual vacuum-pressure method, where the vacuum removes the air from the casting and the compound is forced in under pressure. Variations, though, may be made in this technique to meet certain specialized conditions. After the casting has been impregnated, it is baked two hours at 250 to 275 deg. F. to polymerize the sealing compound. It is desirable to bake the casting under pressure.

The usual industrial cleaners work satisfactorily to remove the synthetic resin-styrene solution from the outside of the castings, after impregnating and before baking the sealing compound.

Model LRJ-3 Fostoria Infra-Red Unit

An infra-red tool for quick heating in the form of a convenient, hand model infra-red unit has been introduced by The Fostoria Pressed Steel Corporation, Fostoria, Ohio. The unit is said to provide an effective means of accomplishing many tasks where quick, easy, controlled heat is required. Its application to metal objects of small area develops relatively high temperatures in from seconds to a few minutes time. For instance, 20-gauge black metal, 1½ in. in diameter, can be heated to 1,000 deg. F. in 1½ minutes when the edge of the reflector is spaced 2½ in. from the metal.

Model LRJ-3 Fostoria Infra-Red Unit

The unit is supplied complete with 375-watt, 110-volt carbon filament infra-red lamp of medium screw base PS-30 type; reflector; cord and plug; off-and-on switch. The LRJ-3 operates on either A.C. or D.C.

"Clad"

The name "Clad" has been given to the line of protective skin creams developed in the chemical laboratories of The B. F. Goodrich Company, Akron, Ohio. Clad is made in two types, for dry and for wet working conditions.

The dry cream is of an improved type which has been made as nearly neutral to the skin as possible. These properties are said to eliminate skin drying or any

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If you require Speed and Fast Feed surfacing for polishing outside diameter of tubing, rods, steel bars and other materials, you will find this PRODUCTION No. 101 polishing machine a real solution to your finishing problem.

No centering, no chucking, no holding. It can be operated with inexperienced labor.

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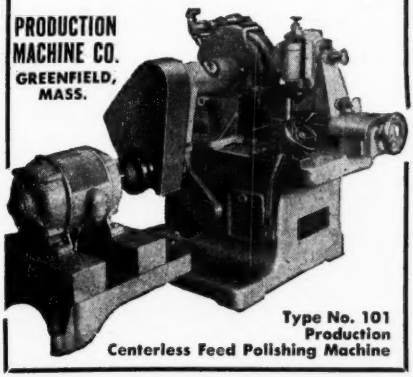

Type No. 101 Production Centerless Feed Polishing Machine

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Now you can eliminate expensive, time-consuming hand operations in the removal of burrs formed in die-casting, stamping, forging and in various machine operations. New HOWARD barrel-type machines effect amazing reductions in time and labor through new improved designs and methods—no matter what metals are used or how rough or fine the finish required. Write for complete information or send sample parts to be processed.

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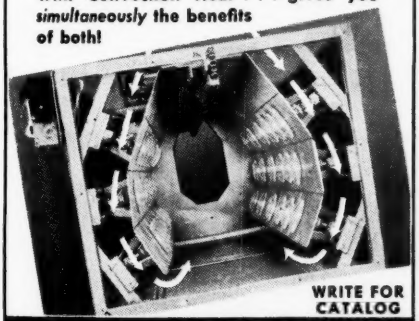

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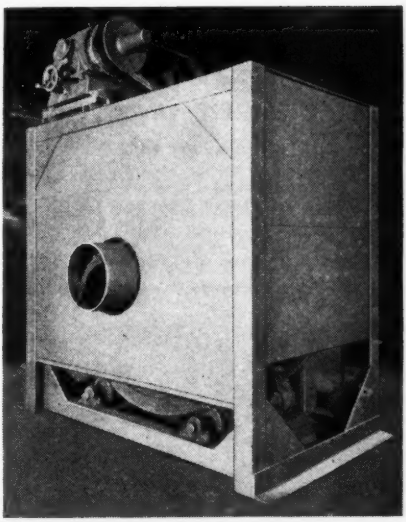

SEND FOR NEW CATALOG

HOWARD Engineering & Mfg. Co.
1056 HULBERT CINCINNATI 14, OHIO

tendency to cause burning or irritation even under prolonged usage. Use of the dry cream protects exposed portions of the body against dirt, grease, grime and any other hard-to-wash-off substances. The company claims that it provides maximum protection and safety.

The cream for wet use is made for protection of the skin where water and other dilute aqueous and mild chemical solutions are present. Both the wet and dry types leave the skin soft and smooth even after the cream is removed.

Industrialists report that use of protective creams greatly assists workers to reduce hazards from dermatitis and reduce "wash-up" time.

U-C Indicator

Techtmann Industries, Inc., 828 N. Broadway, Milwaukee 2, Wis., announces that the Techtmann U-C Indicator has been made adaptable to 30-gal. steel drums, in addition to the 55-gal. steel drums on which it has been used previously.

The U-C tells at a glance the "inside story" about the liquid level content of drums containing oil, solvents, and so on. It is said to eliminate tapping, measuring, guessing, and keeps constant check on the supply of vital liquids.

The indicator fits all 55-gal. and 30-

U-C Indicator

gal. steel drums. The U-C indicator is screwed into the drum faucet opening; then the faucet is screwed into the opening on the indicator body. When the drum is empty, the entire assembly can be removed and attached to a full drum.

"How Zinc Saves Steel from Rusting" is the title of a well-planned booklet which has been prepared by the New Jersey Zinc Company, 160 Front St., New York 7, N. Y. Subjects discussed in the booklet include prevention of corrosion, functions of metal protective paints, formulating metal protective

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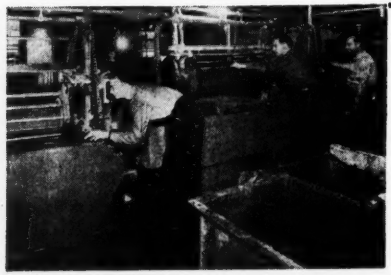

View in large N. Y. plating shop.

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These experienced men expected and obtained a perfectly finished plating job. The metal surfaces of the parts were previously made chemically clean. PERMAG Compounds were used, and it was a foregone conclusion that the work would come out entirely satisfactory.

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A plain white powder . . . harmless to hands or clothing . . . but your definite insurance against RUST. It *will not* injure the most highly finished metal surfaces nor will it *measureably increase the physical dimensions.*

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paints, zinc dust—zinc oxide paints, zinc dust—zinc oxide—iron oxide paints, zinc oxide—iron oxide paints, zinc chromate paints, zinc tetroxy chromate paints, testing metal protective paints, and specifications. The data included in this booklet should prove valuable to anyone connected with the selection and use of paint coatings, both now and in the post-war period. A copy of the booklet may be obtained upon request.

Wrap-Rax, a tape for insulating plating racks and for use as a stop-off, is fully described in Bulletin WR-102 of the Hanson-Van Winkle-Munning Co., Matawan, N. J. This material is a synthetic thermoplastic resin in tape form which is said to possess a high resistance to abrasion and wear and excellent dielectric properties. It is non-blistering even at high temperatures and high current densities when properly applied. It resists chemically all cleaning, pickling and plating solutions commonly used and will not contaminate the solutions. It does not take a plate.

Wrap-Rax can be used for repairing and patching old racks. It requires no handling of cans or drums of liquid, no dipping tanks, and gives off no toxic or inflammable fumes. It is furnished in rolls of approximately 250 lineal ft., from ¾ in. up to 6 or 8 in. wide. Copy of Bulletin WR-102 free upon request.

FOR SALE: — INFRA RED CONVEYOR OVEN
Infra Red Baking Oven complete with steel conveyor 20 ft. long and 4 ft. wide—variable speed from 1½ to 4 feet per minute. Oven consists of 32 1,000 watt C. M. Hall Lamps—220 volts, sockets all assembled in pre-wired channels, all necessary castings, brackets, fittings, etc., in steel frame, four feet wide and eight feet long.
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Tumble-Finishing Equipment. A 12-page catalog, designated as No. B-7, is devoted to the tumble-finishing equipment manufactured by the Globe Machine & Stamping Company, 1200-1250 W. 76th St., Cleveland 2, Ohio. A copy of Catalog B-7 may be obtained on request.

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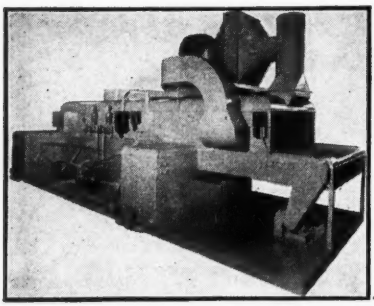
Steam Jet Agitators. Heil Engineering Company, 12901 Elmwood Ave., Cleveland 11, Ohio, has issued a four-page bulletin on steam jet agitators for heating and agitating pickling baths and chemical solutions. The bulletin contains information on a complete series of Heil jets for the direct introduction of steam or air into corrosive solutions to heat them to the optimum temperatures. The jets are designed to give agitation to any or all parts of the vats, increasing the mechanical scouring action and the complete chemical effect upon the contents to be treated. The folder is illustrated with photographs and blue-print drawings. Copy free upon request.



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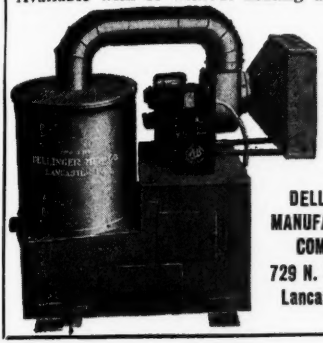

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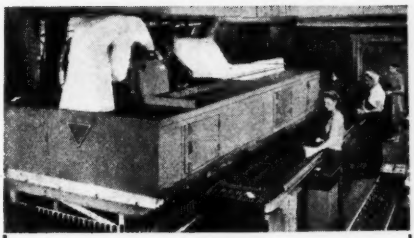

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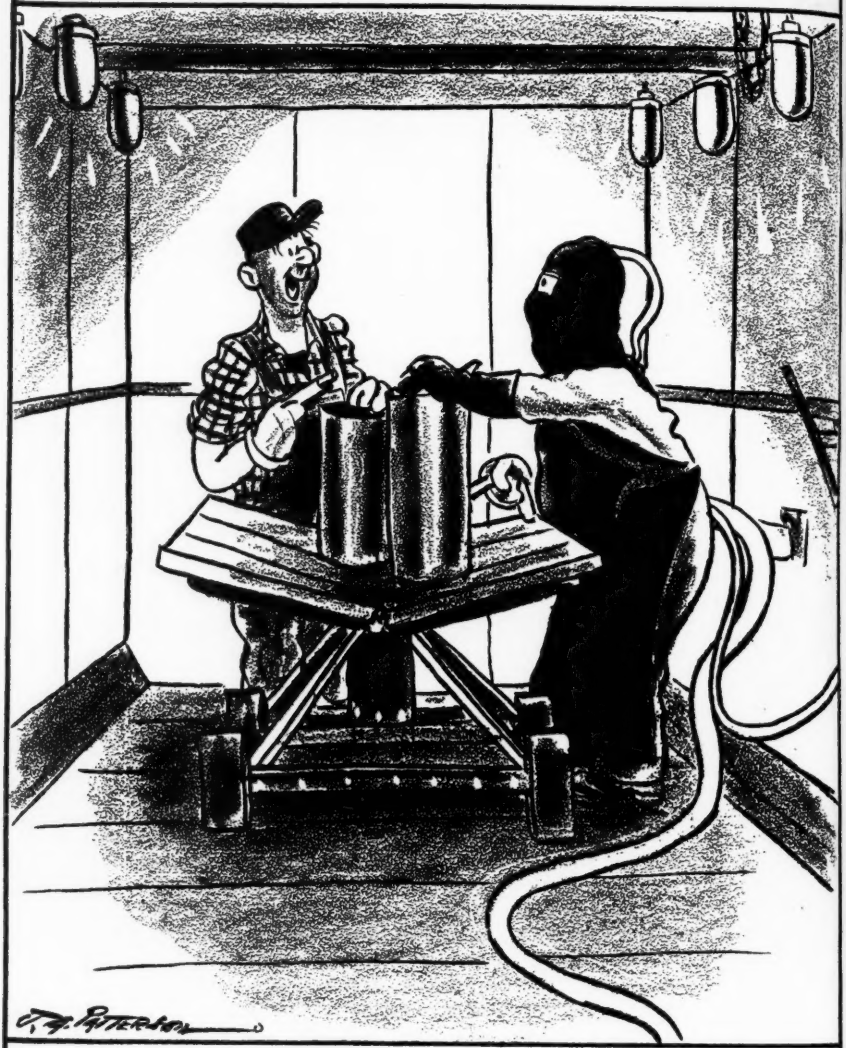

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